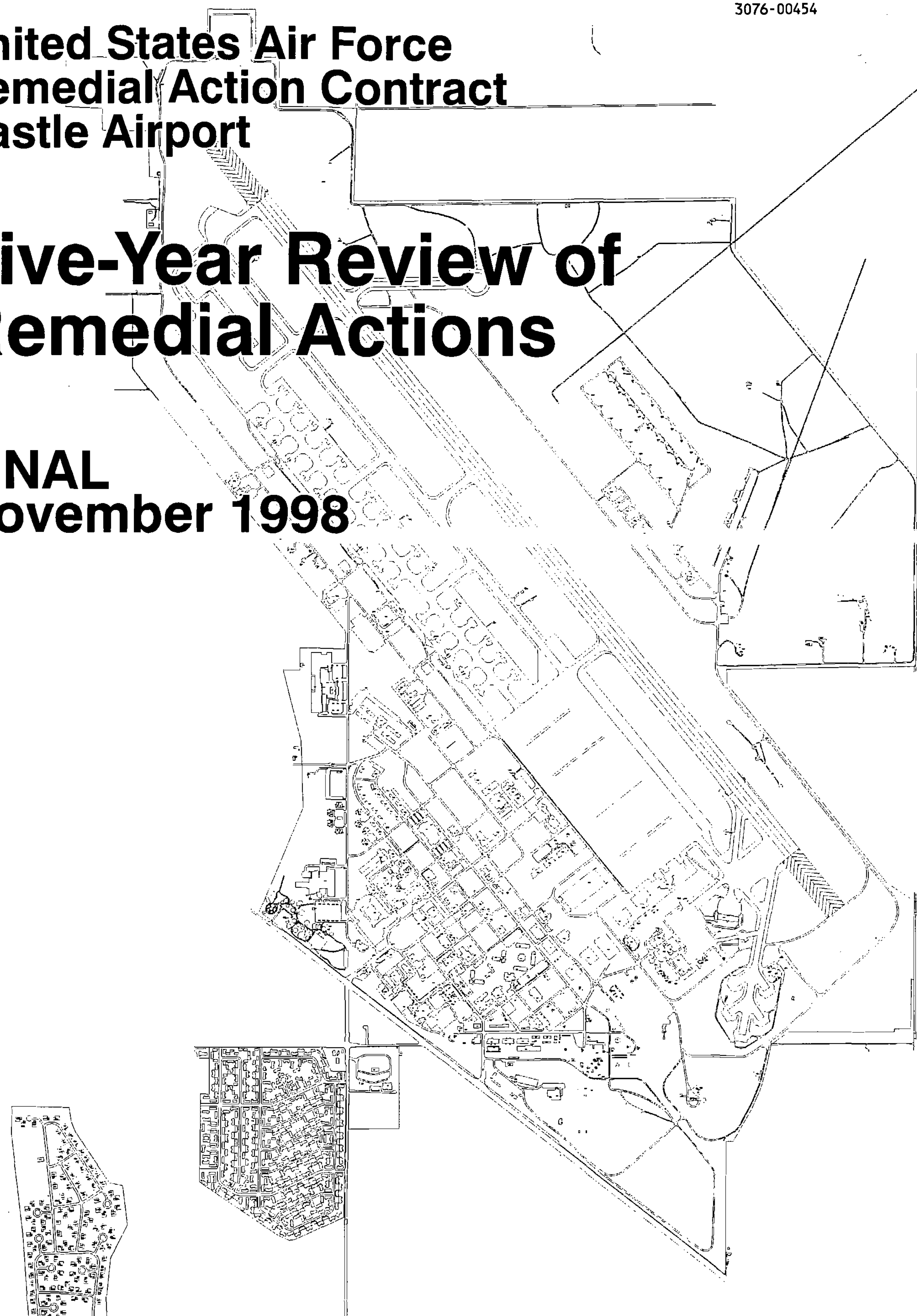
United States Air Force
Remedial Action Contract
Castle Airport

Five-Year Review of Remedial Actions

FINAL
November 1998



3076-00454

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105

4 January 1999

Mr. Albert F. Lowas, Jr.
Director
HQAFBCA/DR
1700 North Moore Street, Suite 2300
Arlington, VA 22209-2802

SUBJECT: Five-Year Review of Remedial Actions, Draft Final, November 1998, Castle Airport (Formerly Castle Air Force Base)

Dear Mr. Lowas:

The United States Environmental Protection Agency (EPA) has reviewed the *Draft Final Five-Year Review of Remedial Actions*, dated November 1998 and prepared on behalf of the Air Force Base Conversion Agency (AFBCA) by Jacobs Engineering. The document satisfactorily addresses the requirements of CERCLA Section 121(c) and of EPA Office of Solid Waste and Emergency Response Directives 9355.7-02 (May 1991), 9355.7-02A (July 1994), and 9355.7-03A (December 1995). It also addresses all of EPA's original comments of 7 August 1998 on the draft version of the document.

We are satisfied that the remedial actions for groundwater remain protective of human health and the environment, and that sufficient progress has been made to date in implementing Phase 3 of the groundwater remedy specified in the *Comprehensive Basewide Part 1 Record of Decision*. We also believe that adequate progress has been made towards cleaning up contaminated soil at Castle Airport. Although remedial actions for soil have not been implemented as yet, the Air Force has undertaken removal actions at the most highly contaminated Source Control Operable Unit (SCOU) sites. We look forward to working with the Air Force towards reaching consensus on the *SCOU Record of Decision* and implementing the remaining necessary remedial actions.

If there are any questions regarding this letter, please feel free to call me at 415-744-2420 or Lisa Hanusiak, Remedial Project Manager, at 415-744-2213.

Mr. Albert F. Lowas, Jr.
Five-Year Review of Remedial Actions
4 January 1999

Sincerely,

Barbara M Smith for D.O.

Daniel D. Opalski, Chief
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12 November 1998

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G5-011

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ON: Contract No. F41624-94-D-8046, Delivery Order 43
CB–Part 2
Jacobs Engineering Project No. 27-G497-00 - Castle Airport

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DEPARTMENT OF THE AIR FORCE
AIR FORCE BASE CONVERSION AGENCY

12 November 1998

MEMORANDUM FOR SEE DISTRIBUTION

FROM: AFBCA/DD Castle
4500 North Hospital Road
Atwater, CA 95301

SUBJECT: Five-Year Review

Please find attached *Five-Year Review of Remedial Actions*. This document fills the requirement established in Section 121 (c) of CERCLA and in Section 300.430 (f) (4) (ii) of the National Contingency Plan. This is the first five-year review conducted at the former Castle Air Force Base that was triggered by Operable Unit One remedial action. The subject document is a Type Ia review prepared pursuant to OSWER Directive 9355.7-02 (May 23, 1991), OSWER Directive 9355.7-02A (July 26, 1994), and OSWER Directive 9355.7-03A (December 21, 1995).

Comments received from U.S. EPA and DTSC on the 8 Apr 98 submittal have been incorporated. Please review and sign the subject document within 30 days of receipt.

If you have any questions, please call Mr. Todd Lanning at (209) 726-4304.

Robert R Matthews
ROBERT R. MATTHEWS, P.E.
BRAC Environmental Coordinator

Attachment:
Five-Year Review of Remedial Actions

c:\cb\5yr.ltr

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3076-00454

Castle Airport

Five-Year Review of Remedial Actions

Final

November 1998

prepared for
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Castle Airport, California

prepared by
Jacobs Engineering
2525 Natomas Park Drive, Suite 370
Sacramento, CA 95833

USAF Contract No. F41624-94-D-8046, Delivery Order 43
Jacobs Project No. 27-G-497-00

Air Force Center for Environmental Excellence
Environmental Services Office/Environmental Restoration
Brooks Air Force Base, TX 78235-5000

Castle Airport

Five-Year Review of Remedial Actions

Final

November 1998

This report was prepared by Jacobs Engineering under the supervision of the professionals whose signatures appear below.

Campbell McLeod
Project Manager

11/12/98
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Richard Bateman, Ph.D., R.G.
Senior Hydrogeologist

11-12-98
Date

For:
Robert Sextro
Quality Assurance Manager

11-12-98
Date

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FIVE YEAR REVIEW CLARIFICATION AND CERTIFICATION STATEMENT

Based on the information provided in this Five Year Review, the groundwater and soil remedies implemented to date at Castle Airport are functioning as designed, remain protective of human health and the environment, and are being operated and maintained appropriately, subject to the explanation below.

Issues involving the installation and operation of wellhead treatment at the City of Atwater's municipal well AM-6 currently remain unresolved between the State of California, the U.S. EPA, and the Air Force. The Air Force re-evaluated the proposed remedial action for AM-6 described in this Five Year Review subsequent to the preparation of this document, but prior to its acceptance by signature of the involved parties. As such, the text of this Five Year Review that describes the proposed installation and operation of wellhead treatment for AM-6 as part of the remedial strategy for the Castle Vista plume is no longer current or accurate. The Air Force and the regulatory agencies are continuing discussions on this issue, and hope to resolve them shortly. In the meantime, the parties agreed that this Five Year Review should be finalized as written, with this notation concerning AM-6, rather than expend additional funds to unnecessarily revise the document.

Albert F. Lowas, Jr.
Albert F. Lowas, Jr.
Director
Air Force Base Conversion Agency

August 16, 1999
Date

Barbara M. Smith, acting
Chief, Federal Facilities Cleanup Branch
Region IX
US Environmental Protection Agency

Aug 30 1999
Date

Anthony J. Landis
Anthony J. Landis, P.E.
Chief, Northern California Operations
Office of Military Facilities
Department of Toxic Substances Control
California Environmental

9-28-99
Date

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LIST OF ACRONYMS AND ABBREVIATIONS

μg/kg	micrograms per kilogram
μg/L	micrograms per liter
AFBCA	Air Force Base Closure Agency
AFCEE	Air Force Center for Environmental Excellence
Air Force	United States Air Force
ARAR	applicable or relevant and appropriate requirements
B#	Building (number)
bgs	below ground surface
CAFB	Castle Air Force Base
CB	comprehensive basewide
CCL	construction completion list
CCR	California Code of Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFC	chlorofluorocarbons
CFR	Code of Federal Regulations
cfm	cubic feet per minute
cis-1,2-DCE	*cis*-1,2-dichloroethene
CVLF-A (or -B)	Castle Vista Landfill A (or B)
DA	discharge area
DBF	Detonation and Burn Facility
DP	disposal pit
EPA	U.S. Environmental Protection Agency
ESD	explanation of significant difference
ETC	Earth Technology Corporation

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

FFA	Federal Facility Agreement
FML	flexible membrane liner
FTA-#	Fire Training Area (number)
GAC	granulated activated carbon
gpm	gallon per minute
HSZ	hydrostratigraphic zone
Jacobs	Jacobs Engineering
LF-#	Landfill (number)
LSS	Lower Subshallow (HSZ)
LTGSP	Long-Term Groundwater Sampling Program
MCL	maximum contaminant level
MDL	method detection limit
mg/kg	milligram per kilogram
NCP	National Contingency Plan
NFA	no further action
NOV	notice of violation
NPDES	National Pollutant Discharge Elimination System
NPL	National Priority List
O&M	Operation and Maintenance
OU	Operable Unit
OSWER	Office of Solid Waste and Emergency Response
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

PCE	tetrachloroethene
RAB	Restoration Advisory Board
RBDR	Revised Basis of Design Report
RCRA	Resource Conservation and Recovery Act
RI/FS	remedial investigation/feasibility study
ROD	record of decision
RWQCB	Regional Water Quality Control Board
SCOU	Source Control Operable Unit
SVE	soil vapor extraction
SVOC	semivolatile organic compound
SWRCB	State Water Resources Control Board
TBV	threshold background value
TCE	trichloroethene
TEER	Technical and Economic Evaluation Report
TEPH	total extractable petroleum hydrocarbons
TPH	total petroleum hydrocarbons
TVPH	total volatile petroleum hydrocarbons
USS	Upper Subshallow (HSZ)
UST	underground storage tank
VOC	volatile organic compound

1. INTRODUCTION

This Five-Year Review of Remedial Actions for Castle Airport was prepared for the United States Air Force Center for Environmental Excellence (AFCEE) under Contract Number F41624-94-D-8117, Delivery Order 43. This report is the initial five-year review of ongoing groundwater and vadose zone remedial actions at Castle Airport (formerly Castle Air Force Base [CAFB]).

Contamination related to military site use was first detected in production wells at Castle Air Force Base in 1978. A series of site characterization investigations was conducted subsequent to this discovery. These investigations, along with concurrent long-term monitoring programs, identified several areas where the vadose zone and underlying groundwater was impacted, primarily by volatile organic compounds (VOCs). The United States Air Force (Air Force) initiated remedial actions pursuant to the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) at the base beginning with the construction of the Operable Unit 1 (OU-1) groundwater treatment system in March 1993.

1.1 BASIS AND PURPOSE OF FIVE-YEAR REVIEWS

The requirement to conduct five-year reviews for hazardous waste response actions was established in Section 121 (c) of CERCLA and in Section 300.430 (f) (4) (ii) of the National Contingency Plan (NCP), which states that:

> If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after initiation of the selected remedial action.

The purpose and focus of five-year reviews are defined in U.S. Environmental Protection Agency (EPA) Office of Solid Waste and Emergency Response (OSWER) Directives 9355.7-02 (EPA, 1991), 9355.7-02A (EPA, 1994), and 9355.7-03A (EPA, 1995). The stated purpose of five-year reviews is to evaluate whether the remedial action(s) implemented at a site remain protective of public health and the environment. The focus of a five-year review depends on the original goal of the remedial action(s). If protectiveness is being provided through exposure protection (e.g., containment with a cap) and institutional controls, the review should focus on whether the cap remains effective and the controls remain in place. For an ongoing, long-term remedial action that has not yet achieved the cleanup standards set in a record of decision (ROD) (e.g., performance of a pump-and-treat system for contaminated groundwater), the review should focus on both the effectiveness of the technology applied and on the specific performance levels established in the ROD.

1.2 CONDUCTING FIVE-YEAR REVIEWS

The responsibility for conducting five-year reviews rests with the EPA. However, through contracts and/or other agreements, the EPA may authorize other parties to perform the reviews. Under Executive Order 12580, the Air Force is authorized to perform the initial and all subsequent five-year reviews for Castle Airport. The EPA retains final review and approval authority for Castle Airport five-year reviews.

Two basic types of five-year reviews are defined in the OSWER guidance documents: Statutory Reviews and Policy Reviews. A Statutory Review is to be conducted for any site where the selected remedy, once ROD cleanup levels are attained, will not allow unlimited use and unrestricted exposure. A Policy Review is to be conducted for any site where no hazardous substances will remain above levels that allow unlimited use and unrestricted exposure after completion of the remedial action, but where the cleanup levels presented in the ROD will require five or more years to be attained. A Policy Review is appropriate for the ongoing long-term remedial actions at Castle Airport.

The OSWER guidance documents also define three levels (types) of review: a Type I review is the lowest level of evaluation of protectiveness, and is appropriate for most sites with ongoing remedial actions. A Type II review contemplates recalculating selected risks, and is appropriate only if warranted by site-specific circumstances. A Type III review involves data collection and a new risk assessment and would be used only where site conditions show such a level of effort to be necessary for an evaluation of protectiveness. OSWER Directive 9355.7-02A introduced a Type Ia review to streamline the five-year review process at sites where remedial action is ongoing and to reduce resource needs for such reviews. Sites would typically qualify for a Type Ia review until construction/remediation is complete and the site qualifies for listing on the Construction Completion List (CCL). However, EPA guidance also states that a higher level of review may be appropriate under certain conditions, even when construction is not complete. Conditions noted in the guidance are:

- The work on most OUs has long been completed but work on the last OU may not be finished for a long time.
- The Region (EPA) or the lead agency knows that an applicable or relevant and appropriate requirement (ARAR) for a specific chemical fails to meet new health standards.
- The planned response costs or operation and maintenance (O&M) costs may have dramatically increased, indicating potential failure of one or more components of the remedy.
- Any other circumstances that indicate the remedy may no longer be protective of human health and the environment.

None of these conditions apply to the remedial actions at Castle Airport. Given that multiple remedial actions are ongoing and none of the conditions requiring a higher level of review are met, a Type Ia review is appropriate for Castle Airport.

1.3 TRIGGER DATE FOR INITIAL FIVE-YEAR REVIEW

OSWER Directive 9355.7-02A states that Policy Reviews should be initiated within five years of the completion of physical construction at a site. The phrase "completion of physical construction" is defined as the date a site qualifies for listing on the CCL. A site qualifies for CCL listing at the time of signature of the preliminary or final close out report, the final or no action ROD, or a deletion notice. For the groundwater remedial actions at Castle Airport, this criteria would not be met for at least 15 years. Consequently, through discussions between the Air Force and EPA, the trigger date for Policy Reviews at Castle Airport is the construction start date for the initial remedial action. Construction was started on the OU-1 groundwater treatment system in March 1993 and therefore, the first five-year review for Castle Airport was initiated in March 1998.

A five-year review document was prepared and submitted to the EPA and state regulatory agencies on 8 April 1998. Comments on this original submittal were received from the

California Regional Water Quality Control Board (RWQCB) on 6 July 1998 and from the USEPA on 7 August 1998. The present document incorporates changes based on the comments received and includes additional monitoring results. Formal responses to EPA and RWQCB comments are provided in Appendix A.

1.4 Report Organization

The remainder of this report is organized as follows:

- Section 2, Site Background, introduces the Castle Airport site and provides a brief overview of site characterization and remediation to date. Ongoing groundwater and vadose zone remedial actions are described.
- Section 3, Site Conditions, briefly describes the geologic/hydrogeologic framework and contaminant distribution in groundwater and the vadose zone at Castle Airport.
- Section 4, Remedial Objectives, includes a summary of the objectives of each of the groundwater remedial actions from the CB-Part 1 ROD. For all ongoing groundwater remedial actions, operational data are summarized and the effectiveness of the systems in achieving the performance levels established in the ROD is evaluated. Any areas of noncompliance with the CB-Part 1 ROD are identified. Vadose zone or Source Control Operable Unit (SCOU) sites are identified but are not evaluated, because the SCOU ROD is not final.
- Section 5, Technology Review and Recommendations, provides an overview of the technologies employed in the groundwater and vadose zone remedial actions at Castle Airport. Past and planned system upgrades are identified. Recommendations for future upgrades are provided as appropriate. SCOU sites are not addressed because the SCOU ROD is not final.
- Section 6, Statement on Protectiveness, provides summary documentation that the selected groundwater remedies remain protective of public health and the environment. SCOU sites are not addressed because the SCOU ROD is not final.
- Section 7, Schedule for Out-Year Reviews, presents the schedule for preparing future five-year review documents for Castle Airport.
- Section 8, References, lists documents cited in the text and all documents reviewed for general background and preparation of the five-year review.
- The single appendix included with the report (Appendix A) presents response to comments on the initial five-year review.

2. SITE BACKGROUND

This section presents background information for Castle Airport, including a site description, an overview of site investigation and monitoring activities, and summary descriptions of the ongoing groundwater and vadose zone remedial actions. SCOU sites that are not related to ongoing removal actions are identified but are not discussed further because the SCOU ROD, which will dictate remedial actions at these sites, is not final.

2.1 SITE DESCRIPTION

Castle Airport, formerly Castle Air Force Base, is located in central California within the San Joaquin Valley in Merced County (Figure 2-1). The site is approximately 6 miles northwest of Merced, near the communities of Winton (north and west) and Atwater (southwest) (Figure 2-2). The former Castle Air Force Base covers an area of 2,777 acres comprising runway and airfield operations, industrial areas, housing, recreational facilities, and several noncontiguous parcels of land located near the base. The largest noncontiguous parcels are two housing annexes of approximately 206 acres, located to the southwest of the main base area.

Castle Air Force Base was established on 20 September 1941 as the Merced Army Flying School. The base was listed on the EPA's National Priorities List (NPL) on 21 November 1987 and was decommissioned on 30 September 1995 under the authority of the Defense Authorization Amendments and Base Closure and Realignment Act of 1988 and the Defense Base Closure and Realignment Act of 1990. Subsequent to closure, the property was renamed Castle Airport. Proposed uses for Castle Airport include a civilian airport, a hospital, educational and recreational facilities, manufacturing facilities, housing, and a federal prison (Jacobs Engineering [Jacobs], 1998a).

2.2 SITE INVESTIGATION AND MONITORING

Groundwater contamination at Castle Air Force Base was first identified in 1978 when trichloroethene (TCE) was detected in groundwater samples from several on-base production wells. Site characterization investigations were begun during 1981 under the Department of Defense Installation Restoration Program. Castle Air Force Base was proposed for the EPA's NPL on 22 July 1987 and was officially designated as an NPL site on 21 November 1987. The Castle Air Force Base Federal Facility Agreement (FFA) was signed by the Air Force, EPA, and the California EPA on 21 July 1989.

Following the inclusion of Castle Air Force Base on the NPL, a comprehensive program of characterizing vadose zone and groundwater contamination was initiated. The extensive site characterization programs have resulted in the installation of several hundred soil and soil vapor borings and in the installation of over 330 monitoring wells within, and in areas adjacent to, Castle Airport. Based on the results of site characterization, the subsurface at Castle Airport consists of a relatively thick vadose zone (approximately 60 to 70 feet). The vadose zone is underlain by five hydrostratigraphic zones (HSZs), designated, in descending order, as the Shallow, Upper Subshallow (USS), Lower Subshallow (LSS), Confined, and Deep HSZs. Monitoring wells have been completed in all of the identified HSZs, but are more numerous in the Shallow and USS HSZs than in the LSS and Confined HSZs. This network of wells allows plume movement and concentrations to be monitored and the effectiveness of vadose zone and groundwater remedial actions to be evaluated. Regular quarterly groundwater monitoring is conducted under the Long-Term Groundwater Sampling Program (LTGSP) established for Castle Airport.

Most characterization and monitoring efforts have been within the Main Base Plume region or area, essentially defined by OU-1 and OU-2 groundwater treatment system outlines, as shown on Figure 2-2. A relatively focused characterization effort has also been conducted in the Castle Vista Plume area, the extent of which is defined by the Castle Vista groundwater treatment system outline shown on Figure 2-2.

VOCs are the primary contaminants in the vadose zone and in groundwater in the Main Base Plume area. TCE has been detected more frequently and at higher concentrations than any other VOC. Groundwater contamination associated with the Main Base Plume has been detected in the Shallow, USS, LSS, and Confined HSZs. The source of the TCE and other minor contaminants is assumed to be military maintenance and operational activities (Jacobs, 1996a).

VOCs are also the primary contaminants in the vadose zone and in groundwater in the Castle Vista Plume area. In this portion of the Castle Airport Site, *cis*-1,2-dichloroethene (*cis*-1,2-DCE) has been detected more frequently and at higher concentrations than any other VOC. Vadose zone contamination is limited to a small area within or adjacent to a former landfill (Castle Vista Landfill B) located in the northeast corner of the area shown on Figure 2-2. Groundwater contamination associated with the Castle Vista Plume has only been detected in the Shallow and USS HSZs. Castle Vista Landfill B is assumed to be the source of the *cis*-1,2-DCE and other minor contaminants (Jacobs, 1997a).

A more detailed discussion of the nature and extent of VOC contamination in the vadose zone and in the Shallow, USS, LSS, and Confined HSZs is provided under the description of site conditions in Section 3.

2.3 GROUNDWATER REMEDIATION

Three removal actions (Discharge Area [DA]-4, Wallace Road, and Building (B)84) and four remedial actions (OU-1, OU-2, Phase 2, and Castle Vista) have been undertaken to date to address groundwater contamination at Castle Airport. A fifth remedial action (Phase 3) is planned. Each of these actions, their interrelationships and purpose in overall groundwater remediation and the controlling documents (RODs), are briefly described and discussed in the following subsections. Table 2-1 provides a summary description of the ongoing groundwater remedial actions at Castle Airport.

2.3.1 Removal Actions

Initial groundwater remediation at Castle Airport consisted of three removal actions (no ROD) to address "hot spots" in the northernmost and central portions of the Main Base Plume region, DA-4, Wallace Road, and B84 (Figure 2-2). The DA-4 removal action began in July 1991 and consisted of one functional extraction well screened in the Shallow HSZ. This well was pumped at a rate of approximately 170 gallons per minute (gpm). The water was treated using liquid-phase granular activated carbon (GAC) then discharged into the Casad Lateral. This system was decommissioned in May 1995. The system's extraction well (DA4-2) was not destroyed and was subsequently incorporated into the OU-2 system. The Wallace Road removal action began operating in December 1991. The system consisted of three extraction wells and a liquid-phase GAC treatment plant. The extraction wells were screened across the Shallow and USS HSZs. Total withdrawal from the three extraction wells averaged about 450 gpm. Treated water was discharged to the Casad Lateral Canal. The system was decommissioned in April 1996 and the three extraction wells destroyed to eliminate the potential for cross-contamination between HSZs. A replacement extraction well (WR4) was completed in the Shallow HSZ and was subsequently incorporated into the OU-2 system.

The B84 removal action operated from January 1993 to January 1994 and consisted of a single extraction well (EW1) and liquid-phase GAC treatment. EW1 was pumped at a rate of about 230 gpm. Treated water was discharged to the Sanitary Sewer System. EW1 was eventually incorporated into the OU-1 system while components of the B84 treatment plant were used for the Phase 2 system.

2.3.2 Remedial Actions

The Comprehensive Basewide (CB)-Part 1 ROD, published on 31 January 1997 and signed by all parties to the FFA by 5 June 1997, established the approach for overall groundwater remediation at Castle Airport (USAF, 1997). The stated objective of the groundwater remedial actions at Castle Airport is to capture the contaminated groundwater plume(s) within the maximum contaminant level (MCL) boundary of the most restrictive contaminant present, and clean up the contaminated groundwater to the MCL. The selected remedy for the Main Base Plume is plume capture (groundwater pump and treat), with a cleanup objective of the MCL for TCE (currently 5 micrograms per liter [μg/L]), to be implemented using a phased approach. This remedy is intended to build on and incorporate ongoing remedial actions (OU-1 and OU-2) originally authorized under the OU-1 Interim ROD (USAF, 1991) and the OU-2 Final ROD (USAF, 1993). These documents are both now superseded by the CB-Part 1 ROD. The Phase 2 groundwater treatment system was designed and implemented under the CB-Part 1 ROD. A Phase 3 expansion of the existing remedial system will be designed and implemented to fully meet the CB-Part 1 ROD objectives.

Groundwater pump-and-treat, with plume capture and cleanup to the MCL of the most restrictive contaminant present, is set forth as a presumptive remedy for the Castle Vista Plume in the CB-Part 1 ROD. This remedial action has been implemented.

The CB-Part 1 ROD further specifies that institutional controls and long-term groundwater monitoring be maintained to address the presence of contaminants in the minor plumes at Castle Airport (North Base, Landfill 1, Landfill 4, and East Base plume regions). These minor plumes are not shown on Figure 2-2 due to scale limitations but are identified on the base map for Figures 3-11 and 3-13. Monitoring is currently conducted under the LTGSP.

In summary, the requirements for groundwater remediation imposed by the CB-Part 1 ROD are (1) plume capture or hydraulic control and (2) treatment to achieve groundwater cleanup to the MCL of the primary contaminant(s). The selected remedies are expected to cost-effectively remove TCE and *cis*-1,2-DCE and other minor contaminants in Castle Airport groundwater to the MCL cleanup objective and to prevent further plume migration. The CB-Part 1 ROD does not establish requirements or goals for contaminant mass removal rates or groundwater extraction rates from the Main Base or Castle Vista plumes or any of the individual HSZs that these plumes affect. The CB-Part 1 ROD does not establish requirements or goals for volume or rate of groundwater treatment by any of the individual groundwater treatment plants (OU-1, OU-2, Phase 2). The CB-Part 1 ROD also does not establish a schedule for remediation i.e., a target date for completion of remediation is not set.

Each of the ongoing remedial actions are briefly described in the following subsections.

2.3.2.1 OU-1

Construction of the OU-1 groundwater treatment system began in March 1993 and the system was placed in service on 29 July 1994. The purpose of the OU-1 system, as stated in the OU-1 Interim ROD, was to remove contaminants from "hot spots" in the "Main Trichloroethylene Plume" (subsequently Main Base Plume) in the Shallow HSZ (USAF, 1991). The system originally consisted of four extraction wells and nine injection wells, all completed in the Shallow HSZ, with groundwater treatment by dual-stage air stripping. Off-gas from the air stripper was, and still is released to the atmosphere in compliance with local air quality regulations. The system was modified during the summer and fall of 1996 to improve performance. Most modifications were to the treatment plant to improve system reliability. They included relocating elements above ground and sealing the data highway and electrical conduits against water infiltration. The treatment plant pad was also upgraded to prevent future flooding. A fifth extraction well was installed and added to the system to increase contaminant mass removal. Present system capacity is approximately 425 gpm. A schematic of the OU-1 system is provided on Figure 2-3; the OU-1 extraction and injection wells, conveyance system, and treatment plant are shown on Figure 2-4.

2.3.2.2 OU-2

The OU-2 groundwater treatment system was placed in service on 26 November 1996. The system was designed in response to improved definition of the extent of the Main Base Plume, resulting from the intensive site characterization/monitoring activities. The purpose of the OU-2 system, as stated in the OU-2 Final ROD, was to control migration of the northern portion of the Main Base Plume and to remove contaminants from the Shallow and USS HSZs (USAF, 1993). The system consists of 15 extraction wells and 11 injection wells, with groundwater treatment by liquid-phase GAC. Present system capacity is on the order of 1,800 gpm. The CB-Part 1 ROD also provides for discharge of treated water to surface water (Casad Lateral) as backup for the OU-2 injection wells. This discharge option is presently permitted (National Pollutant Discharge Elimination System [NPDES]) for up to 500 gpm. A schematic of the OU-2 system is provided on Figure 2-5; the OU-2 extraction and injection wells, conveyance system, and treatment plant are shown on Figure 2-6.

2.3.2.3 Phase 2

The Phase 2 groundwater treatment system went online on 29 September 1997. Objectives of the Phase 2 system were to eliminate the addition of TCE mass to the plume in the

Confined HSZ; remediate "hot spots" of TCE contamination in the USS, LSS, and Confined HSZs; and remediate a residual "hot spot" in the Shallow HSZ. The system consists of seven extraction wells—one in the Shallow HSZ and two each in the USS, LSS, and Confined HSZs—and seven injection wells, all completed in the LSS HSZ. Groundwater treatment is by liquid-phase GAC. Present system capacity is approximately 1,100 gpm. The CB-Part 1 ROD also provides for discharge of treated water to surface water (Castle Airport storm water drainage system with ultimate discharge to Canal Creek) as backup for the Phase 2 injection wells. This optional discharge is presently limited to a design flow of 100 gpm; a technical report demonstrating additional capacity must be submitted prior to any increase to the 100-gpm limit. A further surface water discharge option is provided by an intertie between the pipeline leading to the northern injection well field for Phase 2 and the OU-2 discharge pipeline to the Casad Lateral. A schematic of the Phase 2 system is provided on Figure 2-7; the Phase 2 extraction and injection wells, conveyance system, and treatment plant are shown on Figure 2-8.

2.3.2.4 Castle Vista

Construction of the Castle Vista groundwater treatment system began in early 1997 and was completed in September 1997. The system was placed in continuous operation on 27 October 1997. The Castle Vista system was designed to remediate the *cis*-1,2-DCE plume that exists in the Shallow and USS HSZs to the west and southwest of Castle Vista Landfill B. The system consists of six extraction wells—five in the Shallow HSZ and one in the USS HSZ; eight injection wells—all completed in the Shallow HSZ; and a liquid-phase GAC treatment plant. Present system capacity is approximately 550 gpm. A schematic of the Castle Vista system is provided on Figure 2-9; the Castle Vista extraction and injection wells, conveyance system, and treatment plant are shown on Figure 2-10.

2.3.2.5 Phase 3

The purpose of Phase 3 expansion of the existing groundwater remediation system is to ensure that the system fully meets the remedial objectives defined in the CB-Part 1 ROD for the Main Base Plume. Phase 3 is projected to consist of additional extraction and injection wells and expansion of the existing Phase 2 groundwater treatment plant. The need for

Phase 3 will be based on effectiveness studies of the OU-1, OU-2, and Phase 2 systems. These effectiveness studies were conducted during the summer of 1998 and involved interpreting recent monitoring results and evaluating groundwater flow and contaminant transport model projections. Results of these effectiveness studies, and initial recommendations for Phase 3, have been presented in a draft Technical and Economic Evaluation Report (TEER) (Jacobs, 1998b), submitted for regulatory agency review on 9 October 1998. The present schedule calls for finalization of the TEER, including recommendations for Phase 3, by early March 1999. Completion of Phase 3 construction is tentatively scheduled for the summer of 2000.

2.4 VADOSE ZONE REMEDIATION

During the initial phases of site investigation, over 200 sites with potential vadose zone contamination (SCOU sites) were identified at Castle Airport. The sites were identified based on preliminary field investigations, interviews with site personnel, review of aerial photographs, and agency recommendations. During the SCOU remedial investigation/feasibility study (RI/FS), the SCOU sites were grouped into eight categories based on operations, chemicals/materials used, wastes produced, and potential release types:

- Engine Maintenance Shops
- Washracks
- Landfills and Disposal Pits
- Storage Tanks and Tank Farms
- Utility Pipelines
- Hazardous Waste Storage and Solid Waste Management Units
- Surface Release and Fire Training Areas
- Miscellaneous

The SCOU sites evaluated during the RI/FS process are listed in Table 2-2, grouped as above, and their locations are shown on Plate 1. The status of the majority of SCOU sites is not listed in Table 1-2 because the SCOU ROD is not final and thus, remedial decisions have not been finalized. Those SCOU sites where a removal action has been completed, is ongoing, or is in the planning stages, are identified. Removal actions have been completed and regulatory agencies have concurred with no further action (NFA) recommendations at two SCOU sites; B871 and the Detonation and Burn Facility (DBF). Removal actions are in progress or closure status negotiations are ongoing at 11 SCOU sites: Discharge Area (DA)-4 (includes B1314); Fuel Spill (FS)-1; FS-2, Earth Technology Corporation (ETC) –10; polychlorinated biphenyl (PCB) –9; Fire Training Area (FTA)-1; DA-8 (includes B1550, ST1552, Sanitary Sewer 6, and Sanitary Sewer 7); Castle Vista Landfill A (CVLF-A); Castle Vista Landfill B (CVLF-B); Landfill (LF)-2; and LF-4 (including Disposal Pits [DP]-5 and -6). Removal actions are in the planning stages for LF-1, LF-3 (involving the firing range and DA-3), and LF-5.

Note that removal actions likely will, but may not, constitute the final remedy for an individual site. Final remedies are selected in the SCOU ROD or subsequent CB-Part 2 ROD and therefore, are not approved until the ROD is signed by all parties. The SCOU and CB-Part 2 RODs will identify sites as requiring remedial action or as requiring NFA based on multiple evaluative criteria, including risk. The sites requiring remedial action will presumably be grouped into one of five categories established in the draft SCOU ROD (Waste Policy Institute, 1997):

- Volatile Organic Compound Sites
- Landfill Sites
- Shallow Contamination Sites
- Miscellaneous Sites Requiring Institutional Controls
- Multiple Contaminant Sites

A brief summary of the completed and ongoing removal actions is provided in the subsections which follow. These summaries are more detailed than those provided above for the groundwater remedial actions because the SCOU removal actions are not further evaluated in Sections 4 or 5 of this report. These and other SCOU sites will be further evaluated in subsequent five-year reviews when the SCOU ROD and CB-Part 2 ROD and final remedial action decisions are in place.

2.4.1 Building 871

B871 (Plate 1, Grid T11) is located in the southwestern portion of Castle Airport. An area adjacent to the building was reportedly used as a hazardous waste storage yard during the 1950s. During the SCOU RI, total extractable petroleum hydrocarbons (TEPH); PCBs; lead; and selected pesticides (DDE, DDD, and DDT) were all detected at low concentrations, primarily in surface soil samples.

Four areas of impacted soil, totaling approximately 300 cubic yards, were excavated in March 1996. The excavated soil was loaded directly into trucks and transported to FTA-1, where it was used as fill under a cap being installed at that site (see Section 2.4.6) (Waste Policy Institute, 1997; Jacobs, 1996b). The regulatory agencies concurred with NFA for the B871 site in a letter dated 12 September 1996.

2.4.2 Detonation and Burn Facility

The DBF site (Plate 1, Grid H14) is located in the northeastern portion of Castle Airport. The DBF consisted of two unlined detonation/burn pits used to detonate unserviceable or unsafe ammunition. The pits were approximately 12 feet in diameter and 5 feet deep with an 8-foot high sand berm surrounding them on three sides. In 1993, both the pits and the berm were graded level by Air Force personnel as part of the Range Decontamination Plan.

During the Phase 1 SCOU RI, soil gas samples were analyzed for VOCs and surface soil samples were analyzed for dioxins/furans and explosive compounds. Trace concentrations of benzene; toluene; xylenes; and 1,1,1-trichloroethane were detected in soil gas samples. Octachlorodibenzo-p-dioxin at concentrations up to 1.2 micrograms per kilogram (μg/kg); 1,2,3,4,6,7,8-heptachlorodibenzo-p-dioxin at concentrations up to 0.37 μg/kg; and total heptachlorinated dibenzo-p-dioxins at concentrations up to 0.78 μg/kg were detected in soil samples but were below the practical quantitation limit. An explosive compound (2,4-dinitrotoluene at 6.1 milligrams per kilogram [mg/kg]) was also detected.

Ammunition safing was conducted under the Range Decontamination Plan. Safing involved removing vegetation, excavating soil to approximately 3 feet, sifting and screening the soil with a metal detector, and removing any metal (casings). After the safing was complete, a certificate was issued by the CAFB Explosive Safety Board.

Additional surface scrape samples were collected during removal action data gap sampling conducted in December 1995 and in March 1996. Dioxins and furans were not detected above their method detection limits (MDLs). One explosive compound (RDX at a concentration of 0.10 mg/kg) was detected above the MDL but was below the practical quantitation limit of 0.25 mg/kg.

The Phase 1 RI and data gap sampling at the DBF were conducted to determine the presence and extent of contamination. Because dioxins and explosive compounds were not detected above the practical quantitation limits, it was recommended that the site be categorized as NFA (Jacobs, 1996c). A letter concurring with the NFA recommendation was issued by the regulatory agencies on 26 August 1996.

2.4.3 Discharge Area 4

The DA-4 site (Plate 1, Grid K8) is near the northwest boundary of Castle Airport and incorporates B1314. TCE was detected in concentrations up to 1.2 mg/kg in soil samples and up to 1,000 µg/L in soil gas beneath the French drain system. Results from the SCOU RI suggested that approximately 13,460 cubic yards of VOC-contaminated soil/soil gas existed at the site. A soil vapor extraction (SVE) system was put in place during early 1996. In-ground system components included eight dual-nested vapor monitoring wells, one single vapor extraction well, two dual-nested vapor extraction wells, and one triple-nested vapor extraction well. The SVE treatment unit consisted of a 500 cubic-feet-per-minute (cfm) blower with an air/water separator and two 2,000-pound GAC vessels arranged in series. The system was operated at the DA-4 site from August 1996 to January 1997 (Waste Policy Institute, 1997). A final closure report was issued in April 1998 (Jacobs, 1998c). Discussions regarding site closure, involving the Air Force and regulatory agencies, are ongoing.

2.4.4 Fuel Spill 1

The FS-1 site (Plate 1, Grid L11) is in the central portion of Castle Airport. A fuel spill occurred at this site in November 1977, when approximately 21,000 gallons of JP4 jet fuel were released to the soil. Investigations of soil at the site revealed the presence of total volatile petroleum hydrocarbons (TVPH), or gasoline range hydrocarbons, (up to 5,400 mg/kg) and TEPH, or diesel range hydrocarbons, (up to 20,000 mg/kg), as well as benzene (up to 1.5 mg/kg) and xylenes (up to 440 mg/kg). Contamination appeared to be limited to the upper 40 to 50 feet of soil. Benzene (up to 1,700 μg/L); toluene (up to 5,300 μg/L); and total petroleum hydrocarbons (TPH) (up to 33,000 μg/L) were detected in soil gas samples.

Contamination at FS-1 is limited to petroleum hydrocarbon compounds that are regulated by Resource Conservation and Recovery Act (RCRA) and state requirements but are not contaminants to be remediated under CERCLA. Irrespective, an SVE system was put in place at the FS-1 site and was operated from February 1995 to October 1996. The number and configuration of extraction wells at the site was modified over time. Seventeen vapor wells were installed and used as extraction points during SVE operations. During initial operations, a catalytic oxidation unit with a 1,000-cfm capacity was used to treat extracted vapors. During expanded operations (after October 1995), a thermal/catalytic oxidizer with a 500-cfm capacity was used to treat extracted vapors. Site data suggest that biodegradation has also been effective in reducing contaminant mass at the site (Waste Policy Institute, 1997; Jacobs, 1996d). A draft closure report was issued in January 1998. Based on agency comments, additional confirmation soil sampling will be conducted and a draft final closure report issued.

2.4.5 Fuel Spill 2

The FS-2 site (Plate 1; Grid K9), in the west-central portion of Castle Airport, is the former location of five underground storage tanks (USTs) at a fuel pumping station. The tanks were removed in 1991 but an undetermined amount of JP4 jet fuel was released prior to their removal. Results from a series of site investigations, including the SCOU RI, demonstrated the existence of VOCs, TVPH, and TEPH in shallow soil (upper 20 feet).

Because of site soil conditions and the nature of contamination, it was believed that SVE may not be practical or economical for active mass removal. An SVE demonstration project was conducted at the site during August and September of 1995. Low hydrocarbon mass removal rates were evidenced during the test. Two quarters of intrinsic remediation field monitoring have been conducted since the demonstration to provide support for an NFA recommendation (Waste Policy Institute, 1997). A draft closure report was issued in December 1997 (Jacobs, 1997b). Similar to FS-1, current plans are for additional confirmation sampling of site soil followed by preparation of a draft final closure report.

2.4.6 Earth Technology Corporation 10

The ETC-10 site is in the east-central portion of Castle Airport (Plate 1, Grid L15-L16). Skeet and trap shooting ranges were operated on the site when the base was active. Shards from clay pigeons and lead shot from shotgun shells were readily apparent on the soil surface. Surface samples collected during site investigation contained lead, antimony, and arsenic at concentrations up to 283,000 mg/kg, 6,780 mg/kg, and 1,350 mg/kg, respectively. Polynuclear aromatic hydrocarbons (PAHs) were also detected in surface soils. Concentrations decreased rapidly with depth. Subsurface samples (greater than 3 feet bgs) had lead concentrations only slightly above background levels (95 percent confidence threshold background values [TBV^{95}]).

A removal action conducted at the site from 21 July 1997 to 1 October 1997 consisted of removing surface soil contaminated with lead and PAHs. The excavated soil was transported to the adjacent Landfill 3 (LF-3). Approximately 1,000 cubic yards of lead-impacted soil and 3,000 cubic yards of PAH-impacted soil were removed and transported. The excavated areas within the ETC-10 site were regraded to maintain natural drainage patterns. Minor additional excavation was conducted during August 1998 to address wetland concerns (ecoscrapes). A draft closure report is scheduled for November 1998.

2.4.7 Polychlorinated Biphenyl 9

The PCB-9 site is near the west-central boundary of Castle Airport (Plate 1, Grid N9). A spill occurred at the site in May 1983 that involved oil containing PCBs leaking from a transformer in B1213 onto a concrete sidewalk and grassy area adjacent to the building. Reportedly, the spill was cleaned up very shortly after the event. During the SCOU RI, PCB-containing compounds were detected in surface and near-surface soil samples at concentrations up to 2.8 mg/kg. Excavation of PCB-impacted soil with on-site disposal was the preferred alternative identified in the FS for a removal action at PCB-9.

Initial excavation occurred on 26 January 1998 with the removal of approximately 30 cubic yards of impacted soil (excavation to depth of 1 foot) and removal of impacted concrete. The material was transported to LF-4 where it was incorporated into the foundation layer. LF-4 will ultimately be capped with a Class III cover. Based on confirmation sample results, an additional 10 cubic yards were excavated on 12 February and also transported to LF-4 for disposal. The excavation was backfilled on 17 February 1998 with clean imported fill. A draft final closure report was issued on 19 September 1998.

2.4.8 Fire Training Area 1

The FTA-1 site is on the eastern boundary of Castle Airport (Plate 1, Grid M15). Fire training activities conducted at the site included surface combustion of waste oils, spent solvents, and fuels in unlined burn pits. Various burn pits were used during the active life of the facility and therefore, the contamination is distributed throughout the site.

Site investigation results showed TCE (up to 470 μg/L); benzene (up to 4,300 μg/L); TPH (up to 100,000 μg/L); and other VOCs in soil gas samples, generally from above 40 feet below ground surface (bgs). Aromatic VOCs, including benzene and xylenes; TPH; and SVOCs were detected in soil samples. Several metals, including lead, chromium, copper, nickel, and molybdenum, were detected in soil at concentrations above background levels (TBV^{95}). Several dioxins were detected in soil samples at concentrations up to 2.4 μg/kg.

To address the metal and dioxin contamination in surface and shallow subsurface soils, a surface cap was installed at the site. Installation was completed in July 1996. The cap consists of a foundation layer, a flexible membrane liner (FML), and a vegetative layer. The FML cap is essentially equivalent to a Class III landfill cap. Institutional controls, including access and deed restrictions, are to be maintained as part of the remedy. The cap has been proposed as a final remedy for the metals and dioxin contamination at FTA-1. The surface cap also helps to improve the operating efficiency of the SVE systems described following. A focused feasibility study addressing the necessity and adequacy of this cap was issued in February 1998 (Jacobs, 1998d). Finalization of the report is pending resolution of several remaining issues.

To address the VOC contamination, two SVE removal actions have been conducted. Forty-one vapor extraction wells were installed through the cap. A 250-cfm SVE system was operated from December 1996 to March 1997 and recovered approximately 215 pounds of VOCs, primarily TCE. A larger, 1,000-cfm SVE system has operated at the site since November 1996 and had recovered approximately 60,000 pounds of petroleum hydrocarbons and VOCs through July 1998 (Waste Policy Institute, 1997; Jacobs, 1998d). This SVE system is still operating as of the date of this five-year review.

2.4.9 Discharge Area 8

The DA-8 site is a sanitary sewer and storm drainage area at the southern end of the runway in the Main Base Sector (Plate 1, Grid R13). The DA-8 site includes B1550 and an abandoned washrack (Structure 1552) and associated oil/water separator, and two sections of the sanitary sewer system (Sanitary Sewer 6 and Sanitary Sewer 7). A 5,200-gallon UST was located east of the washrack and was reportedly removed in 1991.

During the SCOU RI, soil and soil gas VOC contamination was detected in the vicinity of the oil/water separator and the sanitary sewer. Contamination extended from the surface to near groundwater. TCE, the organic contaminant detected most frequently at the sanitary sewer location, was reported at concentrations up to 54 μg/kg in soil and up to 1,000 μg/L in soil gas. TCE and *cis*-1,2-DCE were the most frequently detected VOCs in the vadose zone in the vicinity of the oil/water separator. TCE was reported in soil at a maximum concentration of 2,500 μg/kg and in soil gas at up to 2,053 μg/L. *cis*-1,2-DCE was reported in soil at a maximum concentration of 75 μg/kg and in soil gas at up to 97 μg/L. SVOCs were rarely detected in soil samples but were detected in one near surface sample (benzo(b)fluoranthene) at a maximum concentration of 33 μg/kg. RI results indicated that approximately 52,000 cubic yards of VOC-contaminated soil and 300 cubic yards of SVOC-contaminated soil were present at the DA-8 site.

An SVE removal action was initiated at DA-8 in January 1997. Twelve vapor wells were used for active vapor extraction at the site. The extraction/treatment system consisted of a 500-scfm vacuum blower and two 20,000-pound GAC vessels in series. Through 20 August 1997 the system removed approximately 230 pounds of TCE (Waste Policy Institute, 1997; Jacobs, 1997c and 1997d). The SVE system was shut down in August 1998.

2.4.10 Castle Vista Landfill A

CVLF-A is located in the former military housing area southeast of the main portion of Castle Airport (Plate 1, Grid W5). The landfill was unlined and reportedly received municipal wastes from the late 1950s through the early 1960s, prior to Air Force purchase of the property in 1971.

A removal action was initiated at CVLF-A in mid-October 1997. The action consisted of removing all waste material from CVLF-A and consolidating these wastes at LF-4 within Castle Airport (Plate 1; Grid G6-H6). A total of approximately 8,600 cubic yards of waste was removed from CVLF-A. The resulting excavation has been backfilled with clean imported fill. No further action, other than final site restoration, is anticipated at CVLF-A (Waste Policy Institute, 1997; Jacobs, 1998e). A closure report will be issued following final site restoration.

2.4.11 Castle Vista Landfill B

CVLF-B is also located in the former military housing area southeast of the main portion of Castle Airport (Plate 1, Grid U4). The landfill was also unlined and reportedly received residential and commercial refuse and non-biodegradable inert solid waste during the 1950s and 1960s, prior to Air Force purchase of the property in 1971. This landfill is the suspected source of the *cis*-1,2-DCE plume in the Castle Vista area. During site characterization, *cis*-1,2-DCE (at concentrations up to 300 μg/L) and other VOCs, including TCE and tetrachloroethene (PCE), were detected in soil gas samples from multiple borings.

A removal action was initiated at CVLF-B in late October 1997. Similar to CVLF-A, the action consisted of removing all waste material from CVLF-B and consolidating these wastes at LF-4. A total of approximately 66,000 cubic yards of waste was removed from CVLF-B. The resulting excavation was backfilled with clean imported fill (Waste Policy Institute, 1997; Jacobs, 1998e). An SVE system has been installed to address residual soil gas contamination below the excavated area. This system began operation in late September 1998.

2.4.12 Landfill 2

LF-2 is an inactive landfill in the southeastern portion of Castle Airport (Plate 1, Grid T14). The landfill operated between 1951 and 1953 and reportedly received waste consisting of general refuse and perhaps small quantities of unspecified waste chemicals.

A removal action was initiated at LF-2 in mid-December 1997. Similar to CVLF-A and CVLF-B, wastes were excavated and transported to LF-4. The removal action was not completed prior to onset of the 1997-1998 rainy season. The wastes remaining at LF-2 were excavated and transported to LF-4 during August, September, and October 1998. The resulting excavation was backfilled with clean imported fill (Waste Policy Institute, 1997; Jacobs, 1998e).

2.4.13 Landfill 4

LF-4 was an inactive landfill located in the northwest portion of Castle Airport (Plate 1, Grid G6-H6). Available records indicate that LF-4 was used by the Air Force between 1951 and 1970 for the disposal of general refuse, possibly including small volumes of chemical wastes. Two probable disposal pits (DP-5 and DP-6) located in the southern portion of LF-4 reportedly received waste solvents, oils, and miscellaneous liquid chemicals during the active life of the landfill. During the RI, only low VOC and SVOC concentrations were detected in soil samples from borings near these former disposal pits. Elevated concentrations (greater than 10 $\mu g/L$) of chlorofluorocarbons (CFCs) and halogenated VOCs (primarily vinyl chloride) were detected in numerous soil gas samples collected in the vicinity of DP-5 and DP-6.

There is an ongoing program of consolidation of wastes from other Castle Airport landfills at LF-4. Wastes from CVLF-A (completed), CVLF-B (completed), LF-2 (completed), and LF-1 (planned) are involved (see Sections 2.4.8, 2.4.9, and 2.4.10). These wastes, and the waste material already at LF-4, will ultimately be capped with an engineered cover that is compliant with 40 Code of Federal Regulations (CFR) 258.60(a) and (b); 14 California Code of Regulations (CCR) 17773(b) to 17773(e); and 23 CCR 2581(a). Following completion of waste consolidation and capping, a groundwater and soil gas monitoring program will be maintained and all other state requirements for a closed landfill will be followed (Waste Policy Institute, 1997).

Table 2-1
Summary of Groundwater Remedial Actions

Operable Unit 1 (OU-1)

Basis:	OU-1 ROD (Interim, 7 August 1991); superseded by CB-Part 1 ROD (Final, 31 January 1997)
Startup:	29 July 1994
Type:	Pump and Treat Dual-Stage Air Stripper Off-Gas to Atmosphere (no treatment) Injection of Treated Groundwater
System Capacity:	425 gallons per minute
Extraction Wells:	Five (a sixth extraction well [EW03] exists but has never been put online)
Injection Wells:	Nine

Well Designation	Date Installed	HSZ	Casing/Screen Diameter (inches)	Screened Interval (feet bgs)	Calculated Average Flow Rate[1] April 1998 (gpm)
Extraction Wells					
EW01	12/21/90	Shallow	8	67-92	211
EW02	12/28/90	Shallow	8	68-88	18
EW03	NA	Shallow	8	61-86	NIU
EW04	04/29/96	Shallow	8	65-85	38
JE1	07/02/93	Shallow	8	64-84	70
JE2	07/01/93	Shallow	8	61-86	25
Total					362
Injection Wells					
JI1	NA	Shallow	8	NA	NIU
JI2	06/09/93	Shallow	8	60-80	10
JI3	06/15/93	Shallow	8	61-86	38
JI4	06/24/93	Shallow	8	64-89	NIU
JI5	06/23/93	Shallow	8	63-88	NIU
JI6	06/28/93	Shallow	8	62-102	96
JI7	06/17/93	Shallow	8	63-88	55
JI8	06/30/93	Shallow	8	61-86	104
JI9	06/18/93	Shallow	8	63-88	51
Total					354

Notes
[1]The difference between total extraction and injection flow rates is due to flow meter variation and rounding.

bgs	Below ground surface
CB	Comprehensive Basewide
GAC	Granular activated carbon
gpm	Gallons per minute
HSZ	Hydrostratigraphic zone
NA	Not available
NIU	Not in use
ROD	Record of Decision

Table 2-1
Summary of Groundwater Remedial Actions

Operable Unit 2 (OU-2)

Basis: OU-2 ROD (Final, December 1994); superseded by CB-Part 1 ROD (Final, 31 January 1997)
Startup: 26 November 1996
Type: Pump and Treat
Liquid-Phase GAC (four pairs of GAC adsorption vessels, each in series)
Injection of Treated Groundwater
System Capacity: 1,800 gallons per minute
Extraction Wells: 15
Injection Wells: 11

Well Designation	Date Installed	HSZ	Casing/Screen Diameter (inches)	Screened Interval (feet bgs)	Calculated Average Flow Rate[1] April 1998 (gpm)
Extraction Wells					
DA4-2	02/04/91	Shallow	8	76-91	16
EW05	05/07/96	USS	8	110-150	145
EW06	05/15/96	USS	8	106-146	106
EW07	07/09/96	Shallow	8	70-90	111
EW08	05/23/96	USS	8	105-145	168
EW09	05/24/96	Shallow	8	77.5-97.5	113
EW10	06/07/96	Shallow	8	62-92	13
EW11	06/10/96	USS	8	113-153	236
EW12	05/15/96	USS	8	114-154	117
EW13	06/03/96	Shallow	8	67-87	133
EW14	06/12/96	USS	8	110-150	201
EW15	06/05/96	Shallow	8	66-86	106
EW16	07/24/96	Shallow	8	72.5-92.5	48
EW17	05/30/96	Shallow/USS	8	65-85	109
WR-4	06/15/95	Shallow	8	68-93	68
Total					1,690
Injection Wells					
IW01	06/17/96	USS	8	106-166	184
IW02	06/24/96	USS	8	115-175	199
IW03	06/20/96	USS	8	105-175	270
IW04	07/15/96	LSS	8	171-211	200
IW05	07/12/96	Shallow/USS	8	69-99	50
IW06	06/25/96	Shallow/USS	8	74-94	190
IW07	07/02/96	Shallow	8	68.5-98.5	110
IW08	07/03/96	USS	8	115-175	99
IW09	06/04/96	USS	8	95-165	180

Table 2-1
Summary of Groundwater Remedial Actions

Operable Unit 2 (OU-2) continued

Well Designation	Date Installed	HSZ	Casing/Screen Diameter (inches)	Screened Interval (feet bgs)	Calculated Average Flow Rate[1] April 1998 (gpm)
IW10	07/08/96	Shallow	8	70-100	64
IW11	07/17/96	Shallow	8	77-97	140
Total					1,686

Notes
[1]The difference between total extraction and injection flow rates is due to flow meter variation and rounding.

bgs	Below ground surface
CB	Comprehensive Basewide
GAC	Granular activated carbon
gpm	Gallons per minute
HSZ	Hydrostratigraphic zone
LSS	Lower Subshallow
NA	Not available
NIU	Not in use
ROD	Record of Decision
USS	Upper Subshallow

Table 2-1
Summary of Groundwater Remedial Actions

Phase 2
Basis: CB-Part 1 ROD (Final, 31 January 1997)
Startup: 29 September 1997
Type: Pump and Treat
Liquid-Phase GAC (two pairs of GAC adsorption vessels, each in series)
Injection of Treated Groundwater
System Capacity: 1,100 gallons per minute
Extraction Wells: Seven
Injection Wells: Seven

Well Designation	Date Installed	HSZ	Casing/Screen Diameter (inches)	Screened Interval (feet bgs)	Calculated Average Flow Rate[1] April 1998 (gpm)
Extraction Wells					
EW18	12/13/88	Shallow	8	70-90	84
EW19	03/14/97	USS	8	158-173	56
EW20R	04/16/97	LSS	8	200-230	121
EW21	04/02/97	USS	8	105-135	57
EW22	03/24/97	LSS	8	225-245	31
EW23	05/06/97	Confined	8	275-315	198
EW24R	04/09/97	Confined	8	250-290	197
Total					744
Injection Wells					
IW12	04/14/97	LSS	8	190-250	116
IW13	04/21/97	LSS	8	197-247	46
IW14	04/21/97	LSS	8	166-226	58
IW15	04/05/97	LSS	8	179-239	252
IW16	04/17/97	LSS	8	192-242	42
IW17	04/07/97	LSS	8	185-245	197
IW18	04/11/97	LSS	8	187-247	31
Total					742

Notes
[1]The difference between total extraction and injection flow rates is due to flow meter variation and rounding.

bgs	Below ground surface
CB	Comprehensive Basewide
GAC	Granular activated carbon
gpm	Gallons per minute
HSZ	Hydrostratigraphic zone
LSS	Lower Subshallow
NA	Not available
NIU	Not in use
ROD	Record of Decision
USS	Upper Subshallow

Table 2-1
Summary of Groundwater Remedial Actions

Castle Vista
Basis: CB-Part 1 ROD (Final, 31 January 1997)
Startup: 27 October 1997
Type: Pump and Treat
Liquid-Phase GAC (two GAC adsorption vessels in series)
Injection of Treated Groundwater
System Capacity: 550 gallons per minute
Extraction Wells: Six
Injection Wells: Eight

Well Designation	Date Installed	HSZ	Casing/Screen Diameter (inches)	Screened Interval (feet bgs)	Calculated Average Flow Rate[1] April 1998 (gpm)
Extraction Wells					
EW25	06/30/97	Shallow	8	77-97	56
EW26	07/10/97	Shallow	8	66-86	62
EW27	07/03/97	Shallow	8	72-92	64
EW28	07/03/97	Shallow	8	73.5-93.5	67
EW29	07/10/97	Shallow	8	73-93	126
EW30	07/17/97	USS	8	114-134	133
Total					508
Injection Wells					
IW19	06/10/97	Shallow	8	60-95	73
IW20	06/06/97	Shallow	8	60-95	73
IW21	06/11/97	Shallow	8	60-95	73
IW22	07/01/97	Shallow	8	63-93	72
IW23	06/25/97	Shallow	8	59-94	73
IW24	06/13/97	Shallow	8	58-93	73
IW25	06/16/97	Shallow	8	60-95	73
IW26	06/20/97	Shallow	8	63-98	73
Total					583

Notes
[1]The difference between total extraction and injection flow rates is due to flow meter variation and rounding.

bgs	Below ground surface
CB	Comprehensive Basewide
GAC	Granular activated carbon
gpm	Gallons per minute
HSZ	Hydrostratigraphic zone
NA	Not available
NIU	Not in use
ROD	Record of Decision
USS	Upper Subshallow

Table 2-2
Inventory of SCOU Sites

No.	Site Name	Base Sector	Grid Location	Status[1]
	Engine Maintenance Shops			
1.	B23	MBS	P10	
2.	B47	MBS	R11	
3.	B51	MBS	R11	
4.	B52 (B51 Group)	MBS	R11	
5.	B53 (B51 Group)	MBS	R12	
6.	B54	MBS	R12	
7.	B325	MBS	R11	
8.	B541	MBS	S10	
9.	B545	MBS	S10	
10.	B547 (B545)	MBS	S10	
11.	B871/RF	MBS	T11	Removal Action
12.	B950	SBS	T13	
13.	B951 (B950/TCC1)	SBS	T13	
14.	B1204 (B1205)	WBS	M8	
15.	B1205	MBS	M8	
16.	B1207	MBS	M8	
17.	B1253 (B51)	MBS	R12	
18.	B1260 (B54)	MBS	R12	
19.	B1324	MBS	N10	
20.	B1335	MBS	P11	
21.	B1344	MBS	P11	
22.	B1350	MBS	Q12	
23.	B1404	WFLS	L10	
24.	B1529	MBS	Q12	
25.	B1532	MBS	R12	
26.	B1541	MBS	Q13	
27.	B1709	MOBS	L13	
28.	B1762	MOBS	K13	
29.	DA-1 (B950/TCC1)	SBS	T13	
30.	DA-5/HWS-2/HWS-5	MBS	Q13	
31.	ETC-5	MOBS	S12	
32.	F-1	WFLS	L10	
33.	F-2 (F-1)	WFLS	M10	
34.	F-3 (F-1)	WFLS	M10	
35.	F-4	MBS	Q11	
36.	F-5 (F-4)	MBS	Q11	
37.	F-6 (F-4)	MBS	P12	
38.	Stain 19 (B1404)	WFLS	K10	
39.	Structure 55 (B54)	MBS	R12	
40.	Structure T66 (B54)	MBS	R12	
41.	Structure T67 (B54)	MBS	R12	
42.	Structure T85 (B84)	MBS	R11	
43.	Structure 1206 (B1205)	MBS	M8	
44.	SWMU 4.9 (B325)	MBS	R11	
45.	SWMU 4.10 (B325)	MBS	R11	
46.	SWMU 4.11 (B325)	MBS	R11	
47.	SWMU 4.17 (B1260)	MBS	R12	
48.	SWMU 4.18 (B1260)	MBS	R12	
49.	SWMU 4.19 (B1324)	MBS	N10	
50.	SWMU 4.20 (B1590, DA-5)	MBS	Q13	
51.	SWMU 4.21 (DA-8)	MBS	Q12	
52.	SWMU 4.23 (B1541)	MBS	Q13	
53.	SWMU 4.26 (B1253)	MBS	R12	
54.	SWMU 4.27 (B1253)	MBS	R12	

Table 2-2
Inventory of SCOU Sites

No.	Site Name	Base Sector	Grid Location	Status[1]
55.	SWMU 4.29 (B1260)	MBS	R12	
56.	SWMU 4.30 (B1253)	MBS	R12	
57.	SWMU 4.31 (B1350)	MBS	Q12	
58.	SWMU 4.32 (B1532)	MBS	R12	
59.	SWMU 4.35 (B325)	MBS	R11	
60.	SWMU 4.36 (B1324)	MBS	N10	
61.	SWMU 4.38 (DA-5)	MBS	Q13	
	Washracks and Discharge Areas			
62.	B1314 (DA-4)	WBS	K8	Removal action
63.	B1550 (DA-8)	MBS	R13	Removal action
64.	B1562	MBS	R13	
65.	DA-4	WBS	K8	Removal action
66.	DA-6	MBS	T12	
67.	DA-8	MBS	R13	Removal action
68.	Sanitary Sewer 6 (DA-8)	BWS	R13	Removal action
69.	Sanitary Sewer 7 (DA-8)	BWS	R13	Removal action
70.	Structure 1201	MBS	M8	
71.	Structure 1562 (DA-8)	MBS	R13	
72.	Structure 1571	MBS	R14	
73.	SWMU 4.33 (DA-8)	MBS	R13	
	Landfills and Disposal Pits			
74.	Castle Vista Landfill A	Off-Base	W5	Removal action
75.	Castle Vista Landfill B	Off-Base	U4	Removal action
76.	DP-1 (LF-1)	SBS	V13	Removal action
77.	DP-2 (LF-1)	SBS	U13	Removal action
78.	DP-3 (LF-1)	SBS	U13	Removal action
79.	DP-4A/4B	SBS	T13/14	
80.	DP-5 (LF-4)	WBS	H6	Removal action
81.	DP-6 (LF-4)	WBS	H6	Removal action
82.	DP-7 (LF-5)	NBS	F10	Removal action
83.	DP-8 (LF-5)	NBS	E11	Removal action
84.	DP-8A (LF-5)	NBS	E11	Removal action
85.	DP-9 (LF-5)	NBS	E12	Removal action
86.	EP-10 (LF-5)	NBS	G12	Removal action
87.	ETC-11	MOBS	J16	
88.	ETC-12	MOBS	H15	
89.	LF-1	SBS	U13	Removal action
90.	LF-2	SBS	S14/T14	Removal action
91.	LF-3	EBS	K16	Removal action
92.	LF-4	WBS	G6	Removal action
93.	LF-5	NBS	E&F/11/12	Removal action
94.	LF-5 Trenches (LF-5)	NBS	F11/12	Removal action
	Storage Tanks & Tank Farms			
95.	B59 (PFFA)	MBS	S12	
96.	B79 (PFFA)	MBS	S12	
97.	B84	MBS	R11	
98.	B175	MBS	P10	
99.	B508 (PFFA)	MBS	S12	
100.	B909 (PFFA)	MBS	S12	
101.	B917 (PFFA)	MBS	S12	
102.	B1319	WBS	L9	
103.	B1325/HWS-3	MBS	N10	

Table 2-2
Inventory of SCOU Sites

No.	Site Name	Base Sector	Grid Location	Status[1]
104.	B1405	WFLS	L10	
105.	B1560	MBS	Q14	
106.	B1865/1868	EBS	K14	
107.	DA-7 (PFFA)	MBS	S12	
108.	ETC-4 (ST61)	MBS	S12	
109.	ETC-6	MOBS	R10	
110.	FS-1	WFLS	L11	Removal action
111.	FS-2	WFLS	K9	Removal action
112.	FS-3	WFLS	H8	
113.	FS-4	WFLS	L10	
114.	H-4 (UFL-1)	MBS	R10	
115.	JP-4 Fuel Line	BWS	H7, M10	
116.	PFFA	MBS	S12	
117.	Sanitary Sewer 4	BWS	R12	
118.	Sanitary Sewer 8 (PFFA)	BWS	S12	
119.	Stain 24 (FS-1)	MBS	L10	
120.	Stain 36 (B1325)	MBS	N10	
121.	Stain 37 (B1325)	MBS	N10	
122.	Structure T61/HWS-1	MBS	S12	
123.	SWMU 4.4 (B59)	MBS	S12	
124.	SWMU 4.5 (PFFA)	MBS	S12	
125.	SWMU 4.7 (B175)	MBS	P10	
126.	SWMU 4.8 (B175)	MBS	P10	
127.	SWMU 4.13 (B508)	MBS	S12	
128.	UFL-1	MBS	R10	
129.	UFL-2	MBS	R12	
130.	UFL-3	MBS	P11	
131.	UFL-4	MBS	N11	
	Utility Pipelines			
132.	B1182	MBS	Q8	
133.	B1266	MBS	S12	
134.	ETC-7	MOBS	P9	
135.	Industrial Waste Line	BWS	BWS	
136.	Sanitary Sewer 1	BWS	Q10	
137.	Sanitary Sewer 2	BWS	Q10	
138.	Sanitary Sewer 3	BWS	Q12	
139.	Sanitary Sewer 5	BWS	R13	
140.	Sanitary Sewer 9	BWS	Q11	
141.	Storm Drain Systems	BWS	BWS	
142.	SWMU 4.15 (PFFA)	SBS	S12	
143.	SWMU 4.25 (B1182)	MBS	Q8	
144.	SWMU 4.37 (IWL)	BWS	BWS	
	Hazardous Waste Storage Sites and SWMUs			
145.	HWS-4	WBS	K8	
146.	SWMU 4.1	MBS	Q13	
147.	SWMU 4.2	MBS	K8	
148.	SWMU 4.3	MBS	Q13	
149.	SWMU 4.6	MBS	S12	
150.	SWMU 4.12	MBS	S12	
151.	SWMU 4.16	MBS	S13	
152.	SWMU 4.22 (ST1571)	MBS	R14	
153.	SWMU 4.24	MBS	Q8	
154.	SWMU 4.34 (B1319)	WBS	L9	

Table 2-2
Inventory of SCOU Sites

No.	Site Name	Base Sector	Grid Location	Status[1]
	Surface Spills and Fire Training Areas			
155.	B551	MBS	S11	
156.	DA-2	WFLS	M10	
157.	DA-3	MBS	T11	
158.	Detonation & Burn Fac.	MOBS	H14	Removal action
159.	ETC-2	MOBS	T13	
160.	ETC-3	MOBS	S13	
161.	ETC-8	MOBS	N9	
162.	ETC-10	MOBS	L16	Removal action
163.	ETC-13 (ETC-12)	MOBS	G12	
164.	Firing Range	EBS	L16	
165.	FTA-1	EBS	L15	Removal action
166.	FTA-2	WBS	J7	
167.	FTA-3	WBS	K8	
168.	PCB-1, 2, 3 (HWS-6)	WBS	M8	
169.	PCB-4	MBS	S11	
170.	PCB-5	MBS	R10	
171.	PCB-6	MBS	T11	
172.	PCB-8	MBS	R11	
173.	PCB-9	MBS	N9	Removal action
174.	SA B-1 (DA-3)	MBS	T11	
175.	SWMU 4.14 (B551)	MBS	S11	
176.	SWMU 4.28 (DBF)	MBS	H14	
	Miscellaneous Sites			
177.	SA B-2	MBS	T13	
178.	SA B-3 (SA B-2)	MBS	R12	
179.	SA B-4 (SA B-2)	MBS	P12	
180.	Stain-1 (STAIN11,41)	WFLS	H8	
181.	Stain-2 (STAIN11,41)	WFLS	H7	
182.	Stain-3 (STAIN11,41)	WFLS	H8	
183.	Stain-4 (STAIN11,41)	WFLS	J7	
184.	Stain-5 (STAIN11,41)	WFLS	J8	
185.	Stain-6 (STAIN11,41)	WFLS	J8	
186.	Stain-7 (STAIN11,41)	WFLS	J8	
187.	Stain-8 (STAIN11,41)	WFLS	J8	
188.	Stain-9 (STAIN11,41)	WFLS	J9	
189.	Stain-10 (STAIN11,41)	WFLS	J8	
190.	Stain-11	WFLS	J9	
191.	Stain-12 (STAIN11,41)	WFLS	K8	
192.	Stain-13 (STAIN11,41)	WFLS	K9	
193.	Stain-14 (STAIN11,41)	WFLS	K9	
194.	Stain-15 (STAIN11,41)	WFLS	K9	
195.	Stain-16 (STAIN11,41)	WFLS	K9	
196.	Stain-17 (STAIN11,41)	WFLS	K9	
197.	Stain-18 (STAIN11,41)	WFLS	K9	
198.	Stain-20 (STAIN11,41)	WFLS	L9	
199.	Stain-21 (STAIN11,41)	WFLS	L9	
200.	Stain-22 (STAIN11,41)	WFLS	L10	
201.	Stain-23 (STAIN11,41)	WFLS	L10	
202.	Stain-25 (STAIN11,41)	WFLS	L10	
203.	Stain-26 (STAIN11,41)	WFLS	L10	
204.	Stain-27 (STAIN11,41)	WFLS	M10	
205.	Stain-28 (STAIN11,41)	WFLS	M11	
206.	Stain-29 (STAIN11,41)	WFLS	M10	

Table 2-2
Inventory of SCOU Sites

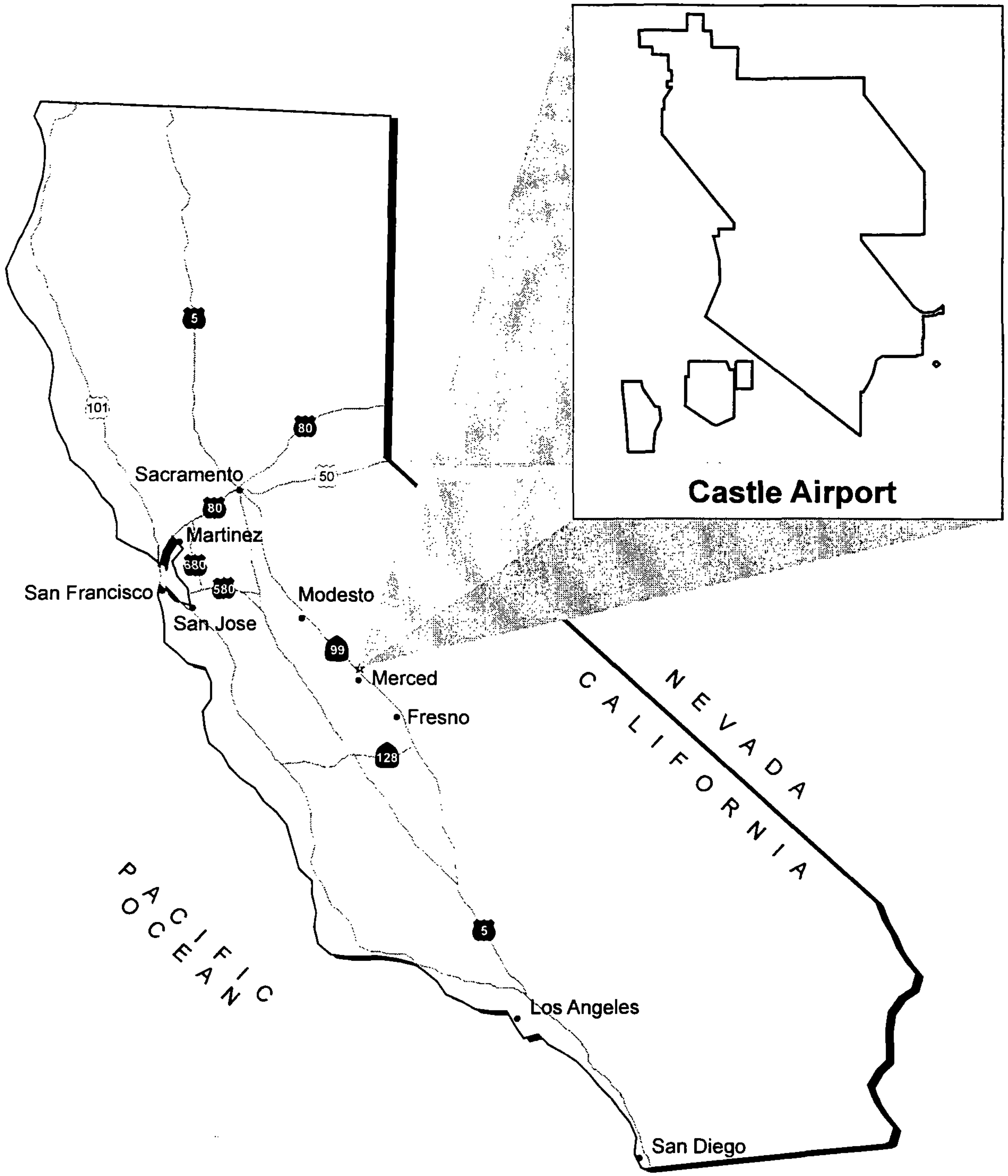
No.	Site Name	Base Sector	Grid Location	Status[1]
207.	Stain-30 (STAIN11,41)	WFLS	M11	
208.	Stain-31 (STAIN11,41)	WFLS	M10	
209.	Stain-32 (STAIN11,41)	MBS	M11	
210.	Stain-33 (STAIN11,41)	MBS	N11	
211.	Stain-34 (STAIN11,41)	MBS		
212.	Stain-35 (STAIN11,41)	MBS		
213.	Stain-38 (STAIN11,41)	MBS	N10	
214.	Stain-39 (STAIN11,41)	MBS	N12	
215.	Stain-40 (STAIN11,41)	MBS	N12	
216.	Stain-41 (STAIN11,41)	WFLS	P12	
217.	Stain-42	MBS	P12	
218.	Stain-43 (STAIN11,41)	MBS	P13	
219.	Stain-44 (STAIN11,41)	MOBS	F8	
220.	PCB-7	EBS	L16	
221.	H-1	MOBS	Locations not shown on Plate 1–sites off base or not of significance	
222.	H-2	MBS		
223.	H-3	MBS		
224.	N-2	MOBS		
225.	N-3	MOBS		
226.	N-6	MOBS		
227.	N-7	MOBS		
228.	N-8	MOBS		
229.	N-9	MOBS		
230.	N-10	MOBS		

Notes
[1]The status of and final remedial actions for SCOU sites will be addressed in the final SCOU ROD or RODs or the CB–Part 2 ROD. Completed and ongoing removal actions are identified, but these actions may not be the final remedial actions for these sites.

B	Building
DA	Discharge area
DBF	Detonation and burn facility
DP	Disposal pit
ETC	Earth Technology Corporation
F	Aircraft maintenance hangar
FS	Fuel spill
FTA	Fire training area
H	Gasoline station
HWS	Hazardous waste storage
IWL	Industrial waste line
LF	Landfill
N	Ground disturbance area
PCB	Polychlorinated biphenyls
PFFA	Petroleum, oil, and lubricants fuel farm area
RF	Recreation facility
SA	Storage area
ST	Structure
SWMU	Solid waste management unit
TCC	Test center cell
UFL	Underground fuel leak

Base Sector

BWS	Basewide Sector
EBS	East Base Sector
MBS	Main Base Sector
MOBS	Miscellaneous and Other Base Sector
NBS	North Base Sector
SBS	South Base Sector
WBS	West Base Sector
WFLS	West Flight Line Sector

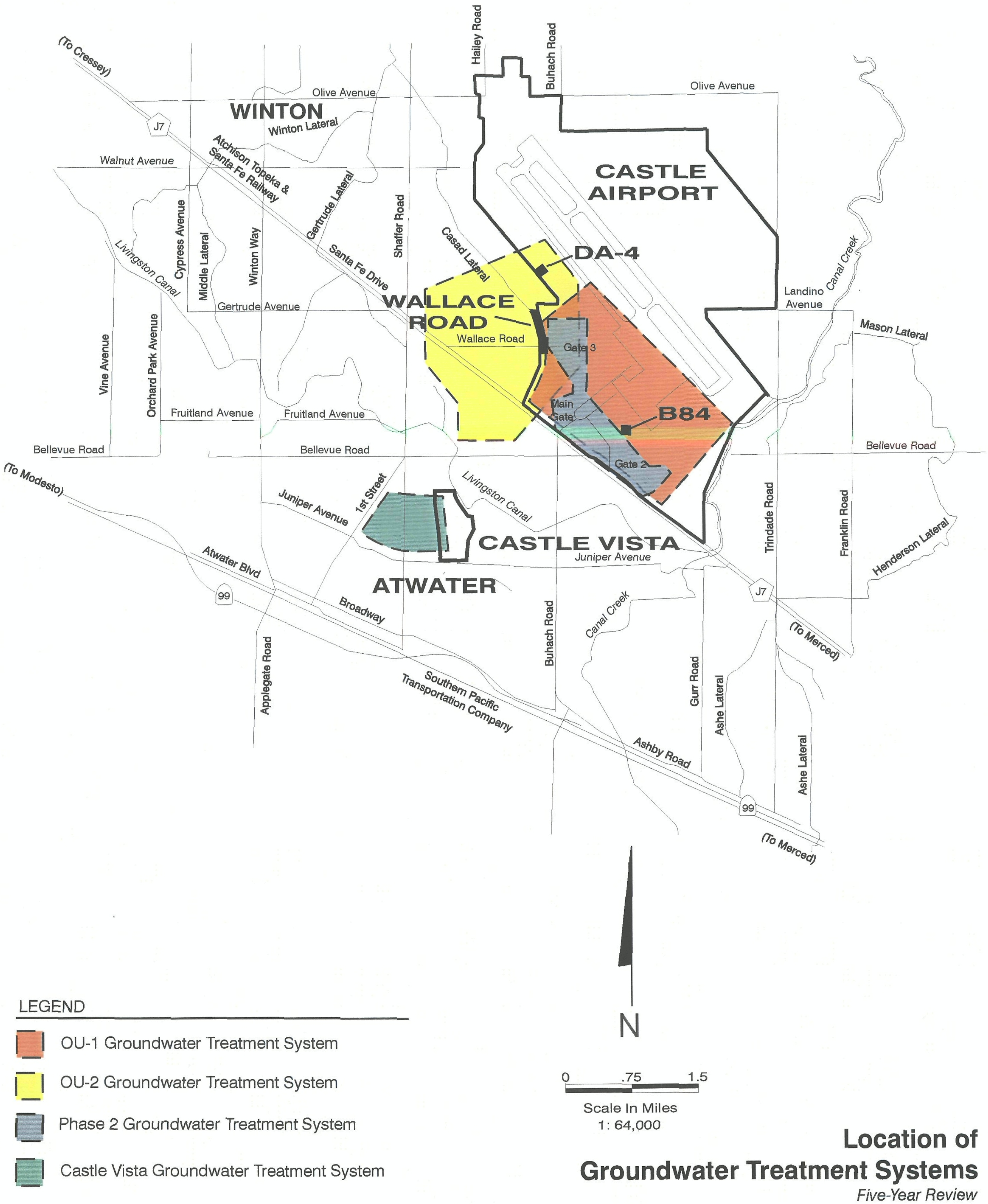


Regional Location Map

Five-Year Review
Castle Airport

03/16/98 jag g:\cadd\27g49700\5yrra\carim.cdr 27G49700

FIGURE 2-1

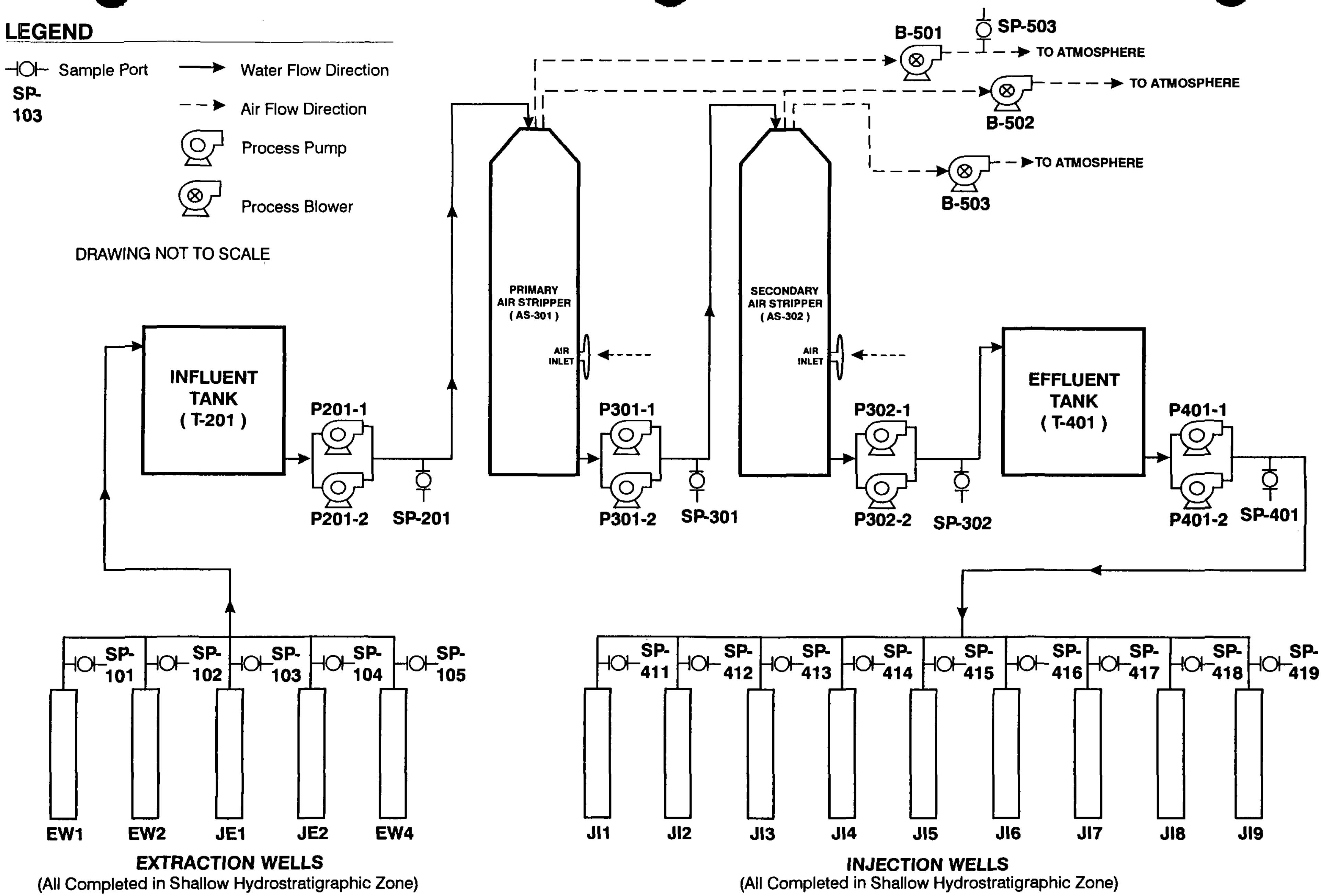


Location of Groundwater Treatment Systems

Five-Year Review
Castle Airport

04/06/98 gmh ...27g49700\5yrra\cloc-ri.cdr 27-G497-00

FIGURE 2-2

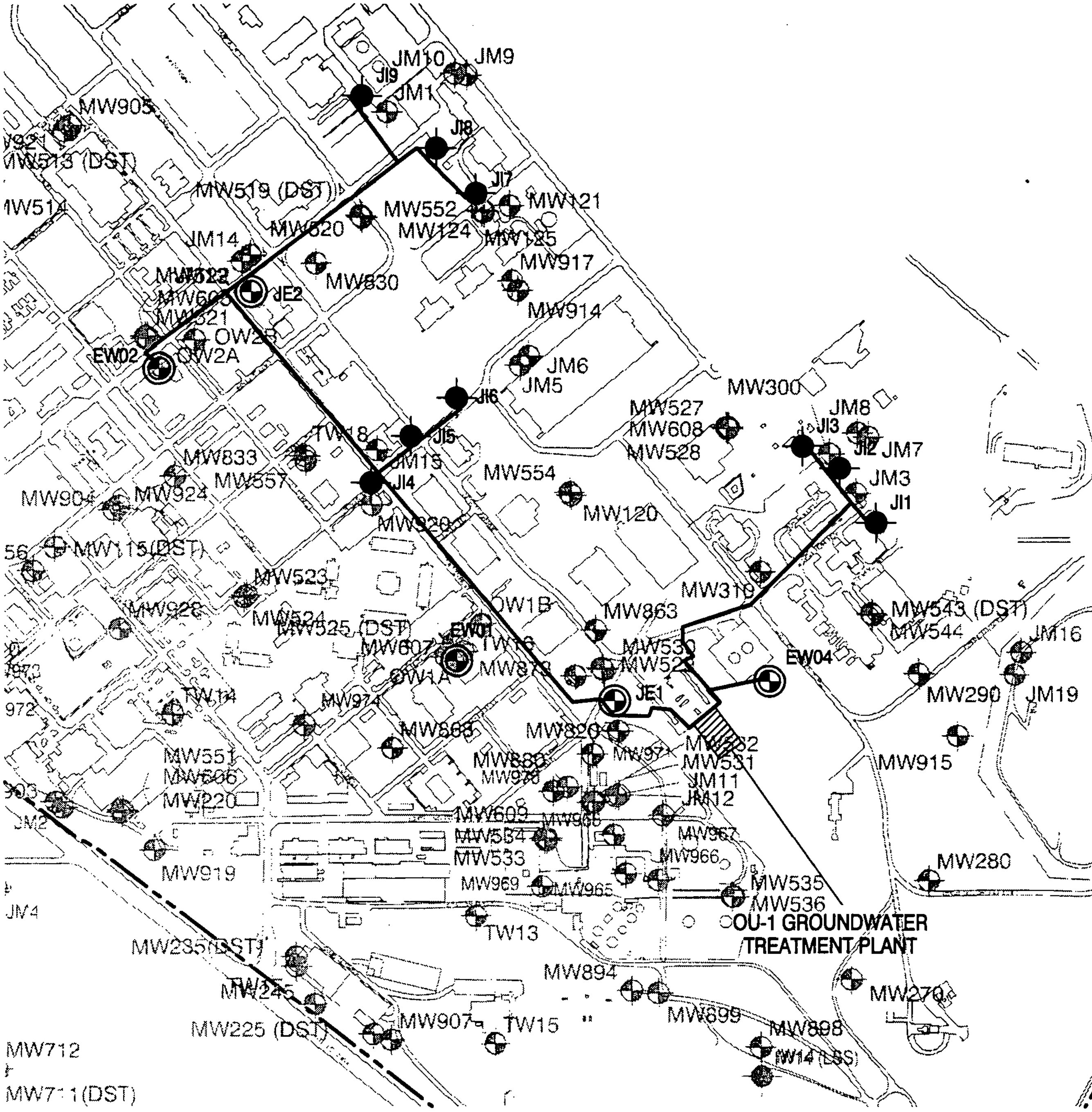


Schematic of
OU-1 Groundwater Treatment System

Five-Year Review
Castle Airport

03/16/98 jag file:..cadd\27g49700\5yrra\splou1.cdr Job No. 27-G497-00
04/05/98 gmh

FIGURE 2-3



LEGEND

OU-1 Injection Well

OU-1 Extraction Well

Injection Well

Extraction Well

Piezometer

Monitoring Well

Extraction/Injection Conveyance System

N

140 0 700
Scale In Feet
1:8400

NOTE: All Extraction and Injection Wells are Screened in the Shallow Hydrostratigraphic Zone.

Extraction and Injection Well Locations and Pipeline Layout - OU-1

Five-Year Review

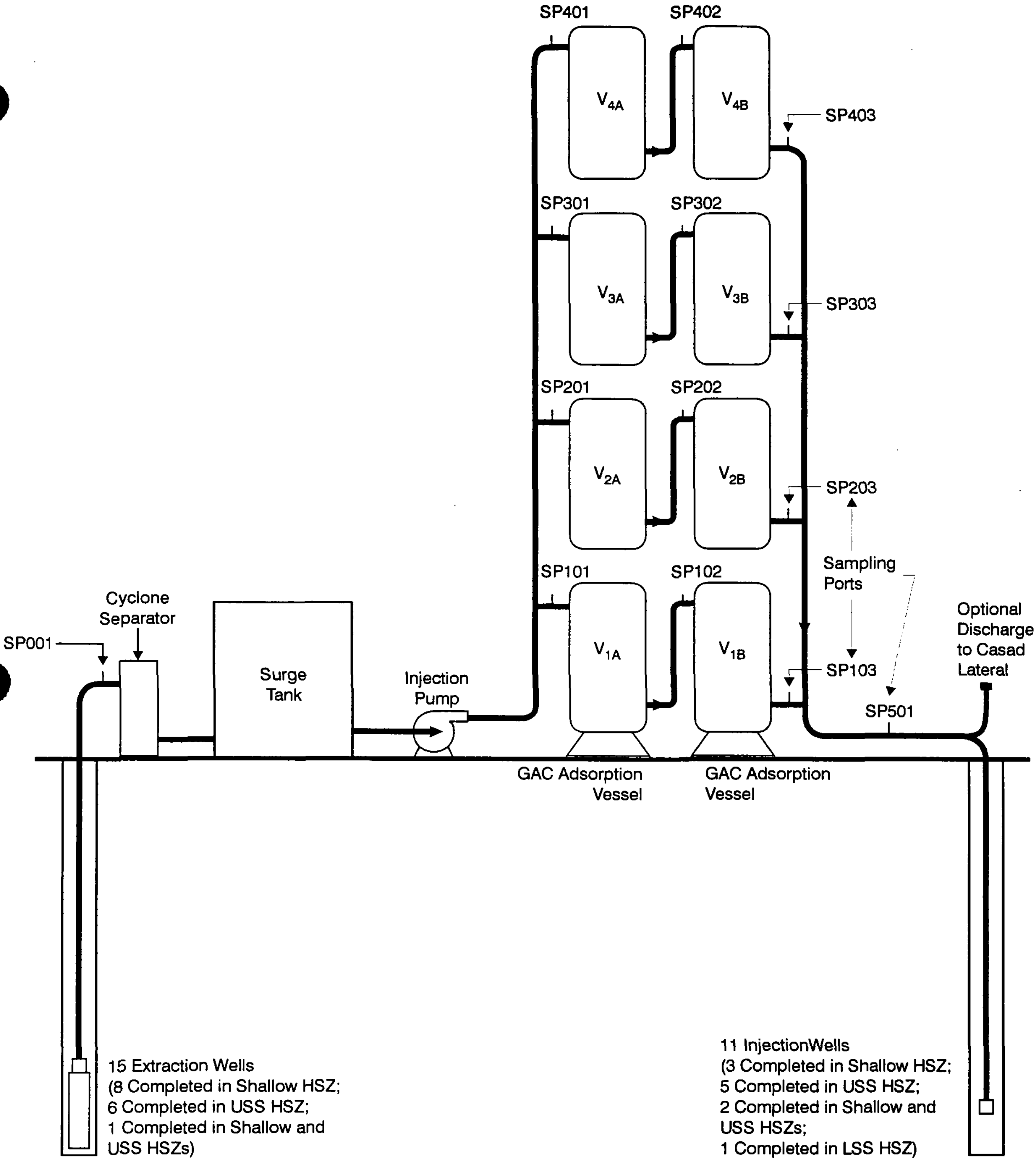
Castle Airport

3/18/98 jag
10/28/98 gmh

g:\cadd\27g49700\5yrra\layou1.dwg

Job No. 27-G497-00

FIGURE 2-4



Drawing not to Scale

LEGEND

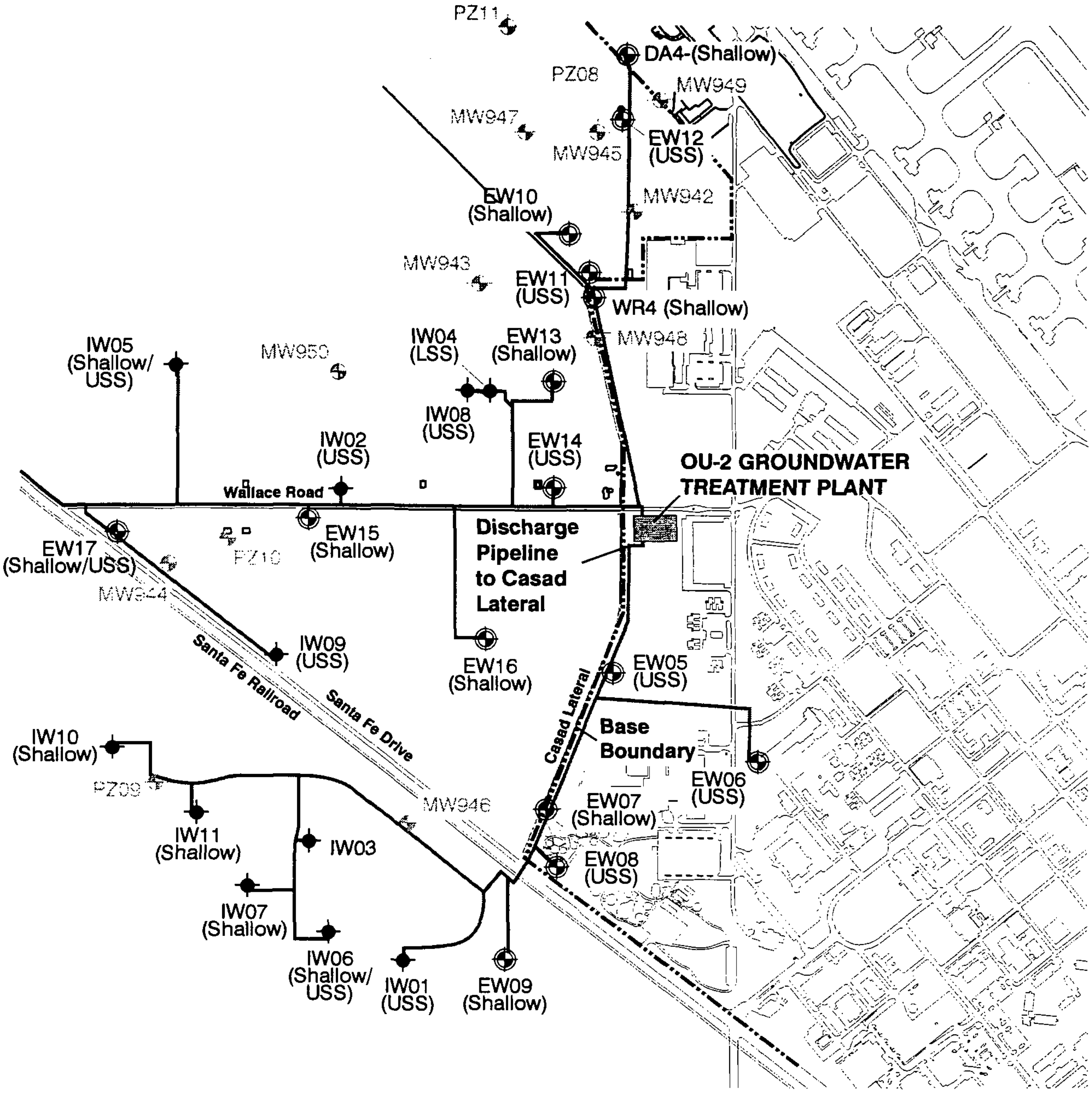
HSZ Hydrostratigraphic Zone
LSS Lower Subshallow
USS Upper Subshallow

Schematic of OU-2 Groundwater Treatment System

Five-Year Review
Castle Airport

6/4/97 sjr file:..cadd\27k49700\5yrra\ou2_tret.cdr Job No. 27-k497-00
11/10/98 gmh

FIGURE 2-5



LEGEND

	Extraction Well
	Injection Well
	Monitoring Well
	Extraction/Injection Conveyance System
(Shallow)	Shallow Hydrostratigraphic Zone
USS	Upper Subshallow Hydrostratigraphic Zone
LSS	Lower Subshallow Hydrostratigraphic Zone

N

200 0 200 400 600 800 1000

Scale In Feet

1:12000

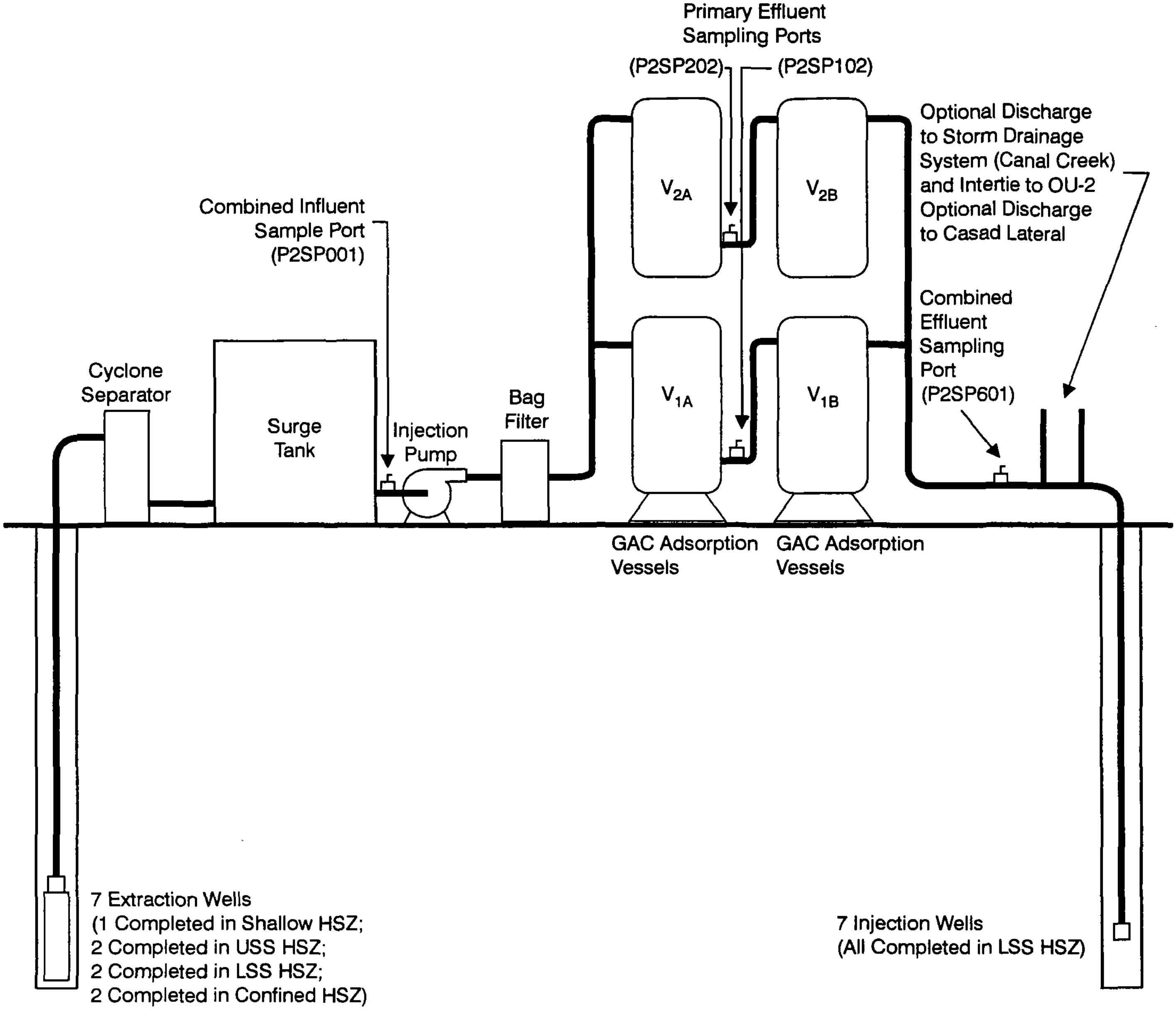
Extraction and Injection Well Locations and Pipeline Layout - OU-2

Five-Year Review

Castle Airport

12/9/96 Drawn By: sjr *File:.cadd\27G49700\5yrra\ph2ewels.cdr* *Job No. 27-G497-00* *FIGURE 2-6*

11/10/98 Rev. By: gmh



Drawing not to Scale

LEGEND

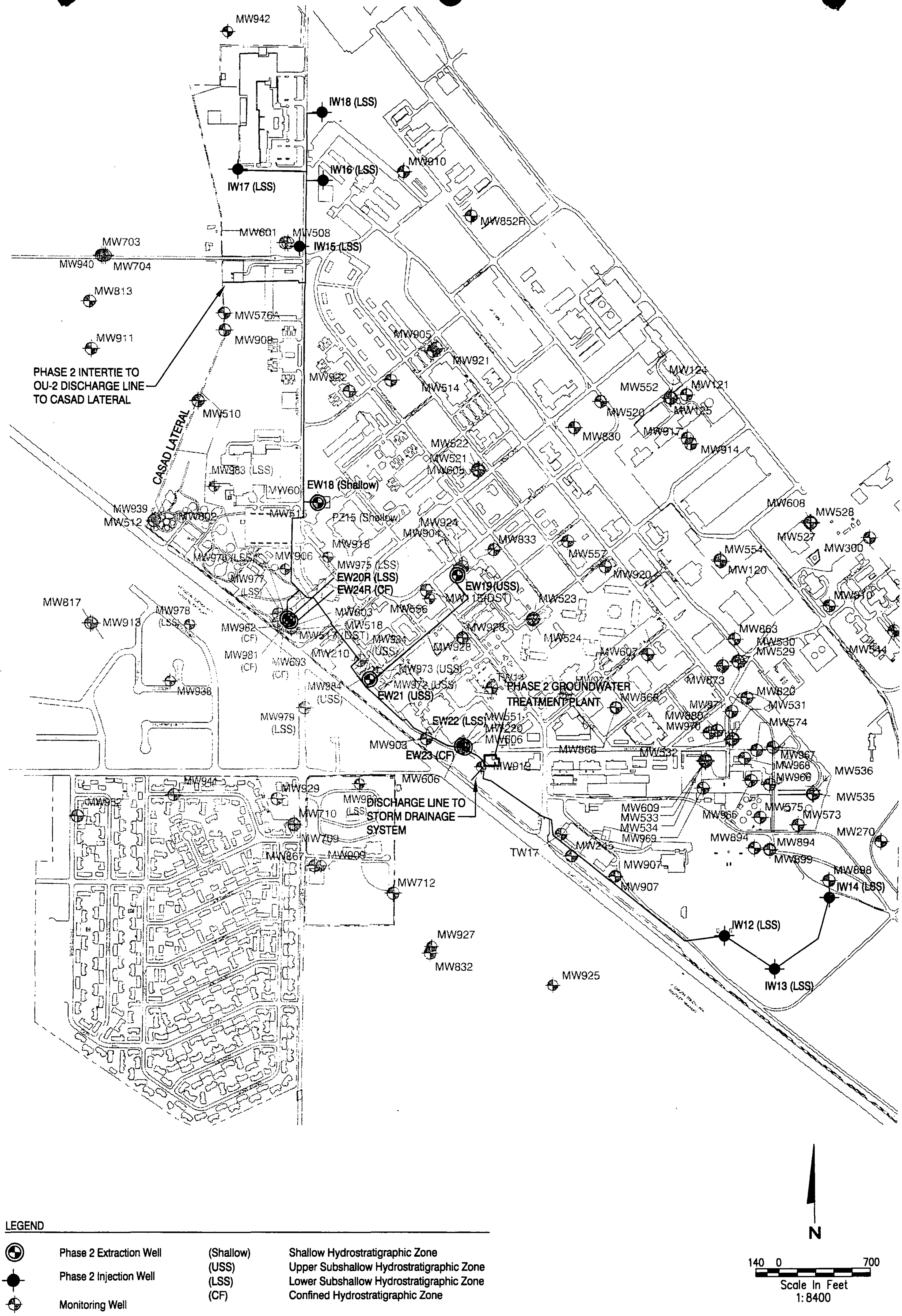
HSZ Hydrostratigraphic Zone
LSS Lower Subshallow
USS Upper Subshallow

Schematic of Phase 2 Groundwater Treatment System

Five-Year Review
Castle Airport

3/18/98 jag File: ..\cadd\27g49700\5yrra\ou2tret2.cdr Job No. 27-G497-00
11/05/98 gmh

FIGURE 2-7



LEGEND

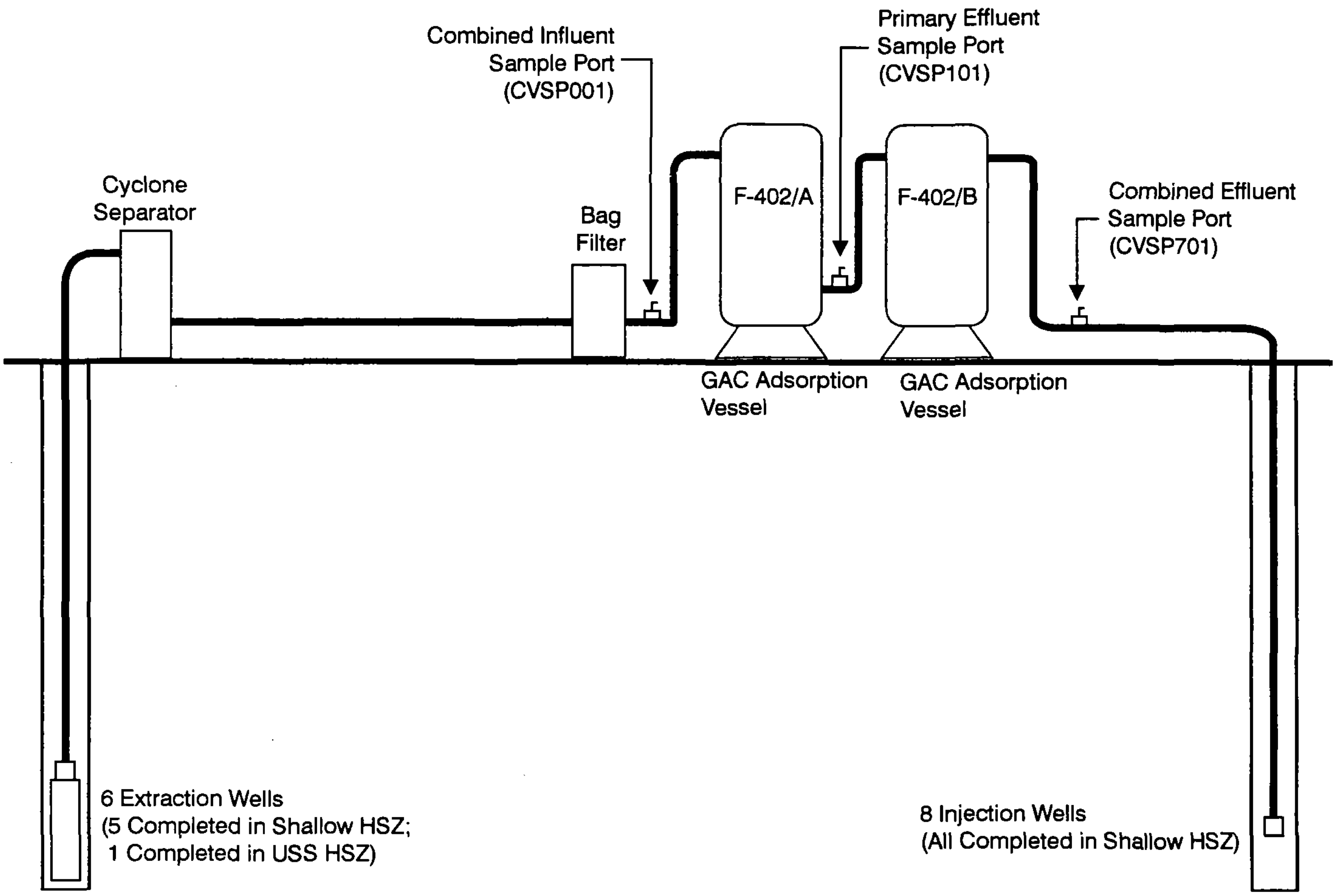
	Phase 2 Extraction Well	(Shallow)	Shallow Hydrostratigraphic Zone
	Phase 2 Injection Well	(USS)	Upper Subshallow Hydrostratigraphic Zone
	Monitoring Well	(LSS)	Lower Subshallow Hydrostratigraphic Zone
	Piezometer	(CF)	Confined Hydrostratigraphic Zone
	Extraction/Injection Conveyance System		

Extraction and Injection Well Locations and Pipeline Layout - Phase 2

Five-Year Review
Castle Airport

3/17/98 jag
11/2/98 gmh
g:\cadd\27g49700\5yrra\ext_inj.dwg
Job No. 27-G497-00

FIGURE 2-8



Drawing not to Scale

LEGEND

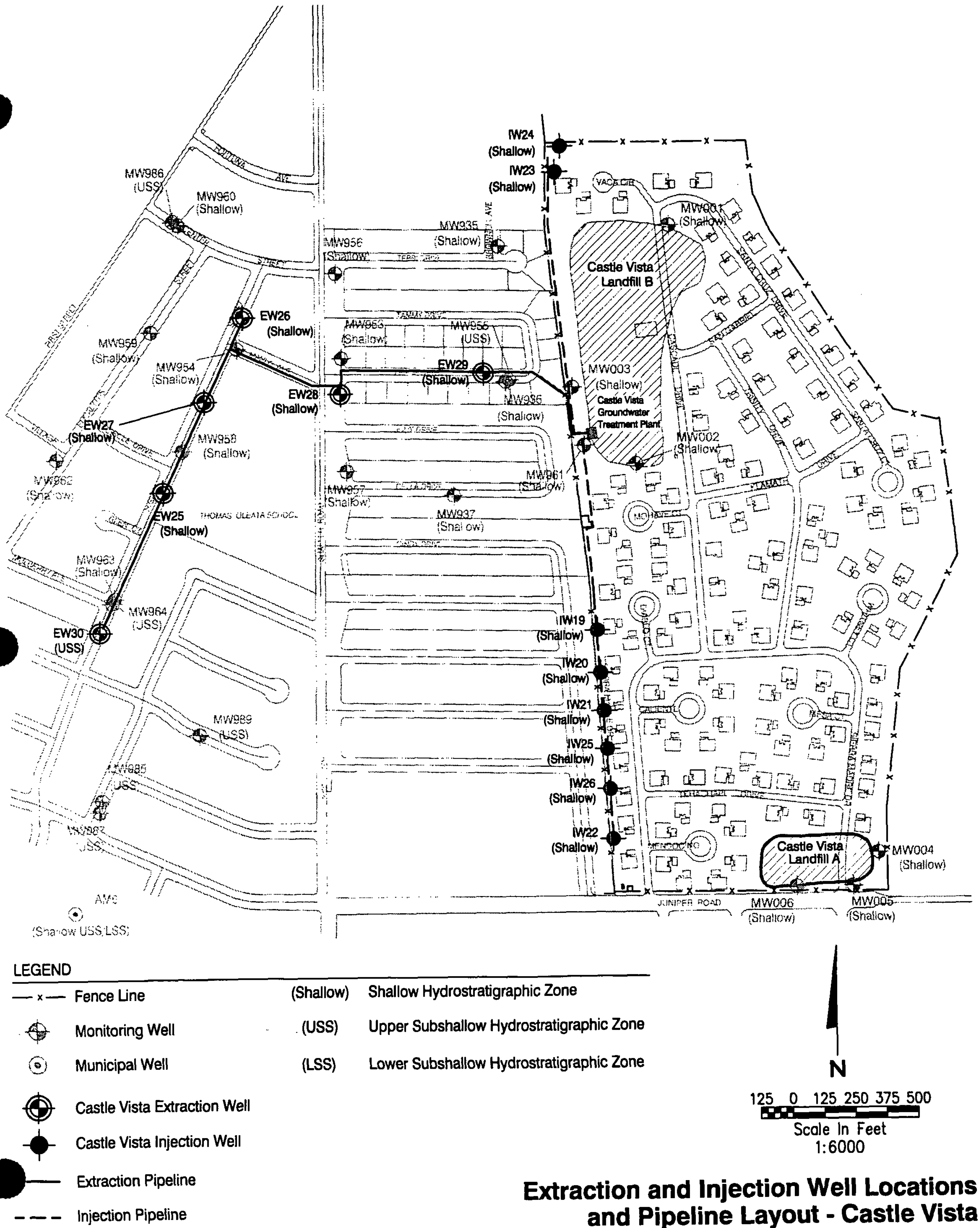
HSZ Hydrostratigraphic Zone
USS Upper Subshallow

Schematic of Castle Vista Groundwater Treatment System

Five-Year Review
Castle Airport

3/16/98 jag File: ..\cadd\27g49700\6yrra\schemat.cdr Job No. 27-G497-00
11/2/98 gmh

FIGURE 2-9



Extraction and Injection Well Locations and Pipeline Layout - Castle Vista

Five-Year Review

Castle Airport

3/16/98 jag
11/2/98 gmh
cadd\27g49700\5yrra\plume2.dwg
JOB 27-K729-01

FIGURE 2-10

PARTIALLY SCANNED OVERSIZE ITEM(S)

See document # 2107754
for partially scanned image(s).

For complete hardcopy version of the oversize document
contact the Region IX Superfund Records Center at
(415) 536-2000

3. SITE CONDITIONS

The following sections briefly describe the geologic/hydrogeologic framework and contaminant distribution in groundwater and the vadose zone at Castle Airport.

3.1 GEOLOGIC AND HYDROGEOLOGIC FRAMEWORK

The geology and hydrogeology of Castle Airport and vicinity have been interpreted from existing geologic and hydrogeologic information, including published maps, geophysical logs, and boring logs from site monitoring wells and from local domestic, irrigation, and municipal supply wells. The conceptual site model developed from these data is described in detail in the Comprehensive Basewide Part 1 Remedial Investigation/Feasibility Study (CB-Part 1 RI/FS) (Jacobs, 1996a). The following brief description of the geologic and hydrogeologic framework at Castle Airport is condensed from the CB-Part 1 RI/FS.

The assemblage of sediments underlying Castle Airport and vicinity consists of five HSZs, designated in descending order as the Shallow, USS, LSS, Confined, and Deep HSZs. The HSZs are not intended to represent separate aquifers but rather to provide an overall structure for stratigraphic correlation. The Deep HSZ is not discussed in this report due to its depth, the top of the zone being at about 350 to 430 feet bgs. A relatively thick vadose zone overlies the Shallow HSZ and extends from the land surface to the water table within the Shallow HSZ, which ranges from approximately 55 to 70 feet bgs. The vadose zone typically consists of dune sand underlain by several feet of hardpan which is, in turn, underlain by laterally discontinuous alluvial clays, silts, sands and gravels.

Hydraulically isolated stratigraphic zones are not generally found at Castle Airport because of the complex alluvial/fluvial stratigraphy that appears to be dominated by localized stream channel deposits. Each of the HSZs is a generally fining upwards sequence of sediments in which the coarse-grained, clean sands and gravels, usually, but not always, occur in the lower portion of the zone. Although there is significant vertical hydraulic communication between HSZs, horizontal permeability predominates within each zone.

3.1.1 Shallow Hydrostratigraphic Zone

The Shallow HSZ is the uppermost water-bearing unit underlying Castle Airport and the surrounding area. This zone is unconfined and extends from the top of the zone of saturation, at about 55 to 70 feet bgs, to an average depth of about 95 feet bgs. In some areas the Shallow HSZ extends to a maximum depth of 115 feet bgs. The lithology is mixed sands, silts, and gravels with minor amounts of clay. The basal unit of the Shallow HSZ appears to consist of sand- and gravel-filled relict stream channels which trend northwest-southeast. These sands and gravels thin and pinch out to the southwest and in the northeastern part of Castle Airport. The average saturated thickness of the Shallow HSZ is about 25 feet—the maximum saturated thickness is about 60 feet, while the minimum is about 5 feet.

Groundwater flow in the Shallow HSZ is generally to the west; locally, the flow direction varies from northwest to southwest due to groundwater extraction and the varying lithology and hydrogeologic properties. The hydraulic gradient in the Shallow HSZ, except in the vicinity of operating extraction and injection wells, is relatively low, typically on the order of 0.001 to 0.002 feet/foot. Figures 3-1, 3-2, and 3-3 show groundwater elevation contours for the Shallow HSZ for the third quarter of 1994 (Q3/94), Q4/96, and Q2/98. The Q3/94 groundwater elevation contours (July 1994) reflect conditions in the Shallow HSZ just prior to OU-1 groundwater treatment system startup (29 July 1994). The Q4/96 groundwater elevation contours (October 1996) reflect conditions in the Shallow HSZ just prior to OU-2 groundwater treatment system startup (November 1996). The Q2/98 groundwater elevation contours (April 1998), the most recent published data available from the LTGSP, reflect the effects of operation of all of the groundwater treatment systems, including the Phase 2 groundwater treatment system (startup 29 September 1997) and the Castle Vista groundwater treatment system (startup 27 October 1997).

3.1.2 Upper Subshallow Hydrostratigraphic Zone

The USS HSZ extends from the bottom of the Shallow HSZ to an average depth of 130 feet bgs, or a maximum depth of about 160 feet bgs. The lithology is heterogeneous both laterally and vertically, consisting mostly of fine-grained flood plain deposits grading into medium-grained sands to the south of Castle Airport. The sands within the unit are lenticular and intermittent, but appear to broaden, thicken, and grade into the channel sands to the south. The average saturated thickness of the USS HSZ is about 35 feet; the maximum saturated thickness is about 65 feet.

Groundwater flow in the USS HSZ, prior to operation of the groundwater treatment systems, was generally to the northwest and west. The direction of flow in the Castle Vista area is to the southwest, likely due to the influence of municipal supply wells. The hydraulic gradient in the USS HSZ, except in the vicinity of operating extraction and injection wells, is typically on the order of 0.001 feet/foot. Figures 3-4 and 3-5 show groundwater elevation contours for the USS HSZ for Q4/96 and Q2/98. The Q4/96 groundwater elevation contours (October 1996) reflect conditions in the USS HSZ just prior to OU-2 groundwater treatment system startup. The Q2/98 groundwater elevation contours (April 1998) show the effects of OU-2, Phase 2, and Castle Vista groundwater treatment system operation.

3.1.3 Lower Subshallow Hydrostratigraphic Zone

The LSS HSZ extends from the base of the USS HSZ to an average depth of 220 feet bgs, or a maximum depth of about 245 feet bgs. The lithology is predominantly fine-grained sands, silts, and clays; however, a 10- to 25-foot thick gravel-bearing horizon occurs intermittently near the base of the zone. The average saturated thickness of the LSS HSZ is about 85 feet; the maximum saturated thickness is about 115 feet.

Groundwater flow in the LSS HSZ, prior to operation of the Phase 2 groundwater treatment system, was primarily to the west. Again excluding areas around operating extraction and injection wells, the average hydraulic gradient in the LSS HSZ may be slightly greater (0.002 to 0.003 feet/foot) than that for the shallower HSZs. Figures 3-6 and 3-7 show groundwater elevation contours for the LSS HSZ for Q4/97 and Q2/98. The Q4/97 groundwater elevation contours (October 1997) documents conditions in this HSZ concurrent with Phase 2 groundwater treatment system startup (29 September 1997). The Q2/98 groundwater elevation contours (April 1998) show the effects of approximately six months of operation of the Phase 2 groundwater treatment system.

3.1.4 Confined Hydrostratigraphic Zone

The Confined HSZ extends from the base of the overlying LSS HSZ to an average depth of 350 feet bgs, or a maximum depth of about 370 feet bgs, within Castle Airport. The unit dips to the west. In the vicinity of the Castle Gardens housing area the base of the Confined HSZ is at an average depth of about 420 feet bgs and at a maximum depth of perhaps 430 feet bgs. The zone is predominantly fine-grained, but also contains more continuous clean sands and gravels than does the overlying LSS HSZ. The North Merced Gravel, which occurs at the base of the zone, does not appear to be laterally continuous, but rather trends north-south in the southwest portion of Castle Airport. This gravel also comprises the majority of the clean sands and gravels in the Confined HSZ. The average saturated thickness of the Confined HSZ is about 125 feet; the maximum saturated thickness is about 185 feet.

Groundwater flow in the Confined HSZ prior to groundwater treatment system operation was consistently to the west. The average hydraulic gradient in the Confined HSZ, except in the vicinity of operating extraction and injection wells, is on the order of 0.002 to 0.003 feet/foot. Figure 3-8 and 3-9 show groundwater elevation contours for the Confined HSZ for Q4/97 and Q2/98. The Q4/97 groundwater elevation contours (October 1997) document conditions in this HSZ concurrent with Phase 2 groundwater treatment system startup (29 September 1997). The Q2/98 groundwater elevation contours (April 1998) show the effects of approximately six months of Phase 2 groundwater treatment system operation.

3.2 DISTRIBUTION OF CONTAMINANTS IN GROUNDWATER

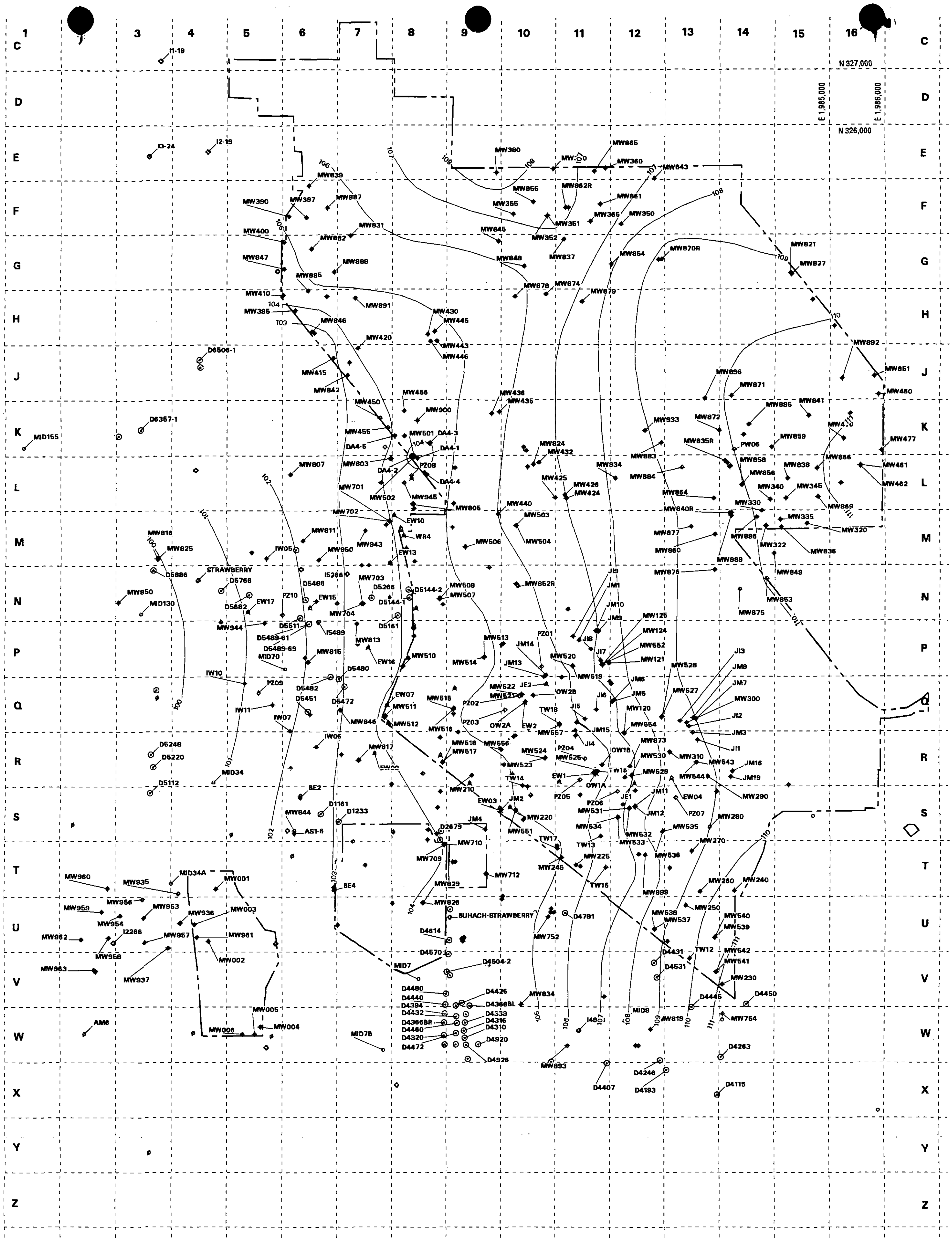
Results from the CB-Part 1 RI and the LTGSP have demonstrated that TCE is by far the predominant contaminant in the Main Base Plume and that *cis*-1,2-DCE is the predominant contaminant in the Castle Vista Plume. Other contaminants occur in groundwater at Castle Airport (primarily other VOCs, SVOCs, and petroleum hydrocarbons), but generally not at concentrations that exceed regulatory levels or result in unacceptable human health or ecological risk. The occurrence of groundwater contaminants other than TCE and *cis*-1,2-DCE is not discussed further. Discussion of those minor groundwater contaminants is provided in the CB RI/FS-Part 1 (Jacobs, 1996a) and comprehensive groundwater monitoring data is provided in the most recent annual report from the LTGSP (Jacobs, 1998a).

Historic and current distribution of TCE and *cis*-1,2-DCE in Castle Airport groundwater is shown on Figures 3-10 through 3-21. Figure 3-10, 3-11, and 3-12 show the distribution of TCE in the Shallow HSZ for Q3/94 (prior to OU-1 groundwater treatment system startup), Q4/96 (prior to OU-2 groundwater treatment system startup), and Q2/98 (after a significant period of OU-1 and OU-2 operation and approximately six months of Phase 2 groundwater treatment system operation). Figures 3-13 and 3-14 show the distribution of TCE in the USS HSZ for Q4/96 (rationale as above) and Q2/98 (rationale as above). Figures 3-15 and 3-16 show the distribution of TCE in the LSS HSZ for Q4/97 (just prior to Phase 2 groundwater treatment system startup) and for Q2/98 (after approximately six months of Phase 2 groundwater treatment system operation). Figures 3-17 and 3-18 show the distribution of TCE in the Confined HSZ for Q4/97 (again just prior to Phase 2 groundwater treatment system startup) and Q2/98 (after approximately six months of Phase 2 system operation). Figures 3-19 and 3-20 show the distribution of *cis*-1,2-DCE in the Shallow HSZ for Q4/97 (just prior to Castle Vista groundwater treatment system startup) and Q2/98 (after approximately five months of Castle Vista system operation). Figures 3-21 and 3-22 show the distribution of *cis*-1,2-DCE in the USS HSZ for Q4/97 and Q2/98.

3.3 DISTRIBUTION OF CONTAMINANTS IN THE VADOSE ZONE

Contaminants occur in the vadose zone (in soil and soil gas) at the majority of the SCOU sites identified in Section 2.4. Reported contaminants include VOCs, SVOCs, pesticides, herbicides, petroleum hydrocarbons, and inorganics (metals and gross alpha and beta radiation). The most-frequently reported vadose zone contaminants are VOCs, SVOCs, petroleum hydrocarbons, and metals.

A discussion of the nature, distribution, and concentration of vadose zone contaminants at each of the SCOU sites identified in Section 2.4, or even at only those presently considered for remediation, is beyond the scope of this five-year review. The nature of the vadose zone contamination at SCOU sites with ongoing or planned removal actions was briefly described in Sections 2.4.1 through 2.4.13.



LEGEND

- MW001 Monitoring well
- D4740 Domestic well
- PW15 Production well
- I1-01 Irrigation well-private
- MID1 Irrigation well-public
- EW01 Extraction well
- JI6 Injection well
- AM11 Municipal well
- PZ03 Piezometer

Property boundary

Groundwater elevation contours in feet above mean sea level; dashed where inferred

Note: Map recreated from old map; Well elevation data unable to be duplicated

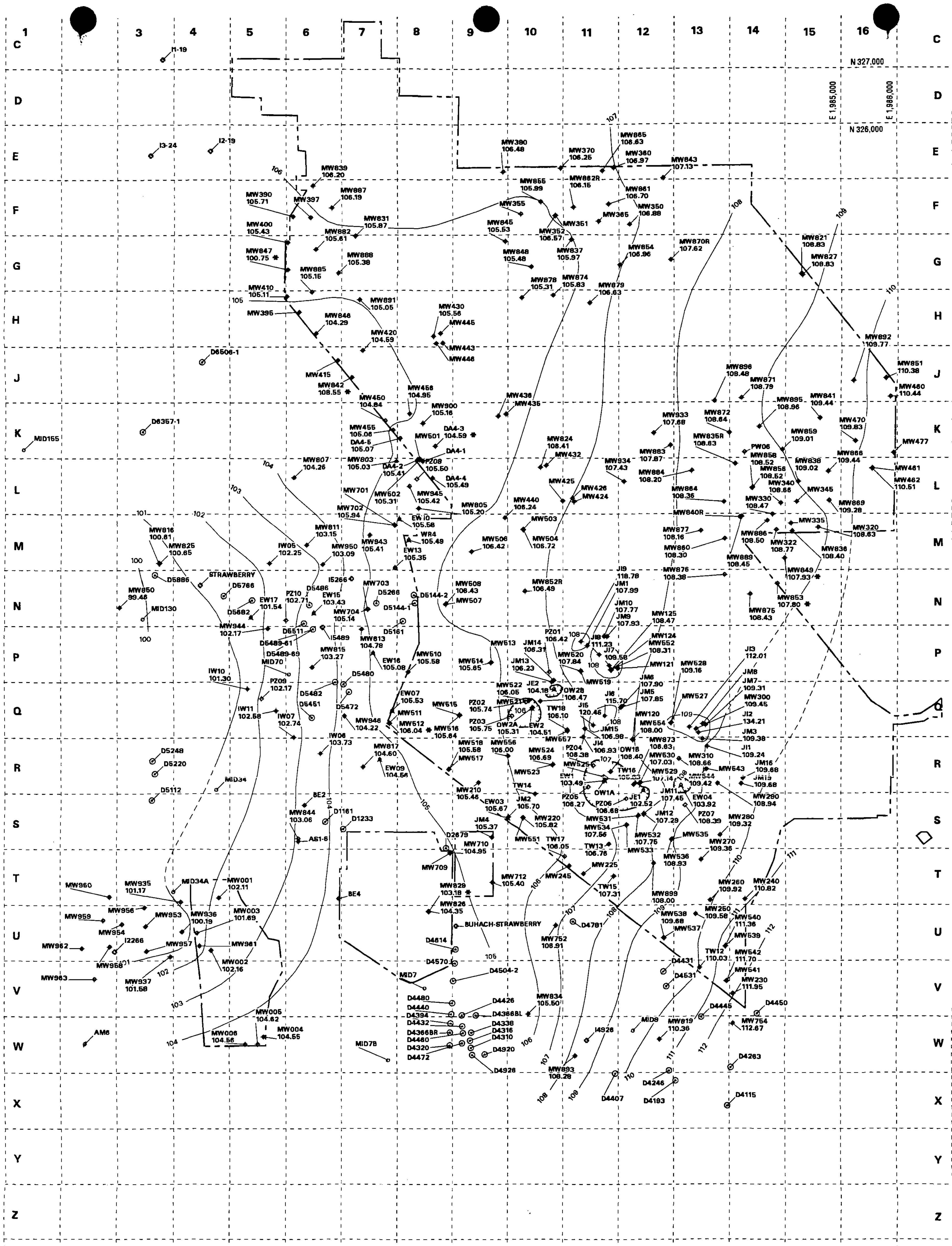
N

0 1700

Scale in Feet 1:20400

Groundwater Elevation Contours, Third Quarter 1994
Shallow Hydrostratigraphic Zone

Five-Year Review
Castle Airport



LEGEND

MW001	Monitoring well
D4740	Domestic well
PW15	Production well
I1-01	Irrigation well-private
MID1	Irrigation well-public
EW01	Extraction well
JI6	Injection well
AM11	Municipal well
PZ03	Piezometer
	Area of Groundwater Elevation Drawdown

Property boundary

Groundwater elevation contours in feet above mean sea level; dashed where inferred

MW875
60.11
Well location with groundwater elevation data

* Data not used in contouring

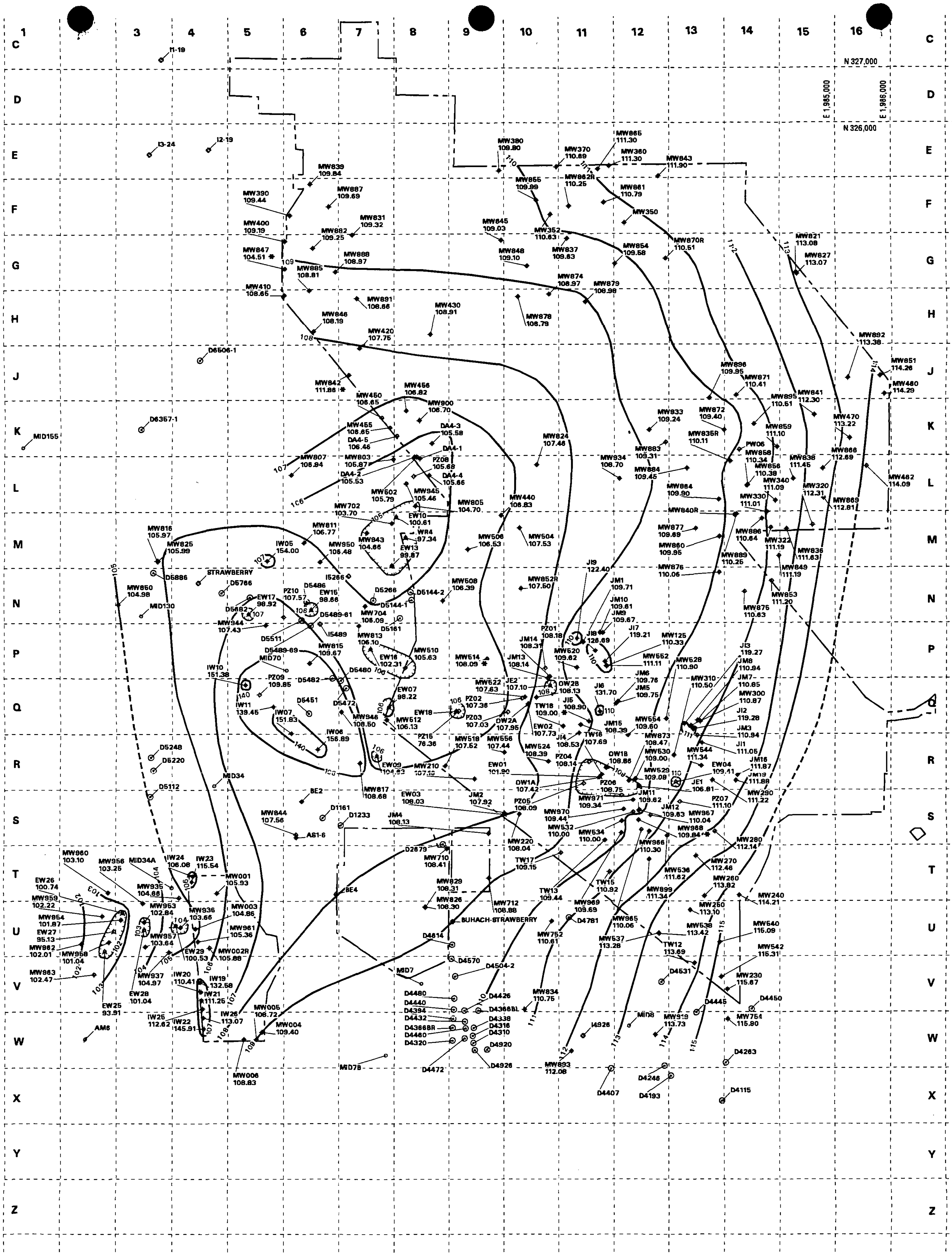
N

0 1700

Scale in Feet
1:20400

Groundwater Elevation Contours, Fourth Quarter 1996
Shallow Hydrostratigraphic Zone

Five-Year Review
Castle Airport



LEGEND

- MW001 Monitoring well
- D4740 Domestic well
- PW15 Production well
- I1-01 Irrigation well-private
- MID1 Irrigation well-public
- EW01 Extraction well
- JI6 Injection well
- AM11 Municipal well
- PZ03 Piezometer

Area of groundwater elevation drawdown

Property boundary

Groundwater elevation contours in feet above mean sea level; dashed where inferred

MW875 60.11 Well location with groundwater elevation data

* Data not used in contouring

Note: Dry wells not shown on map

N

0 1700

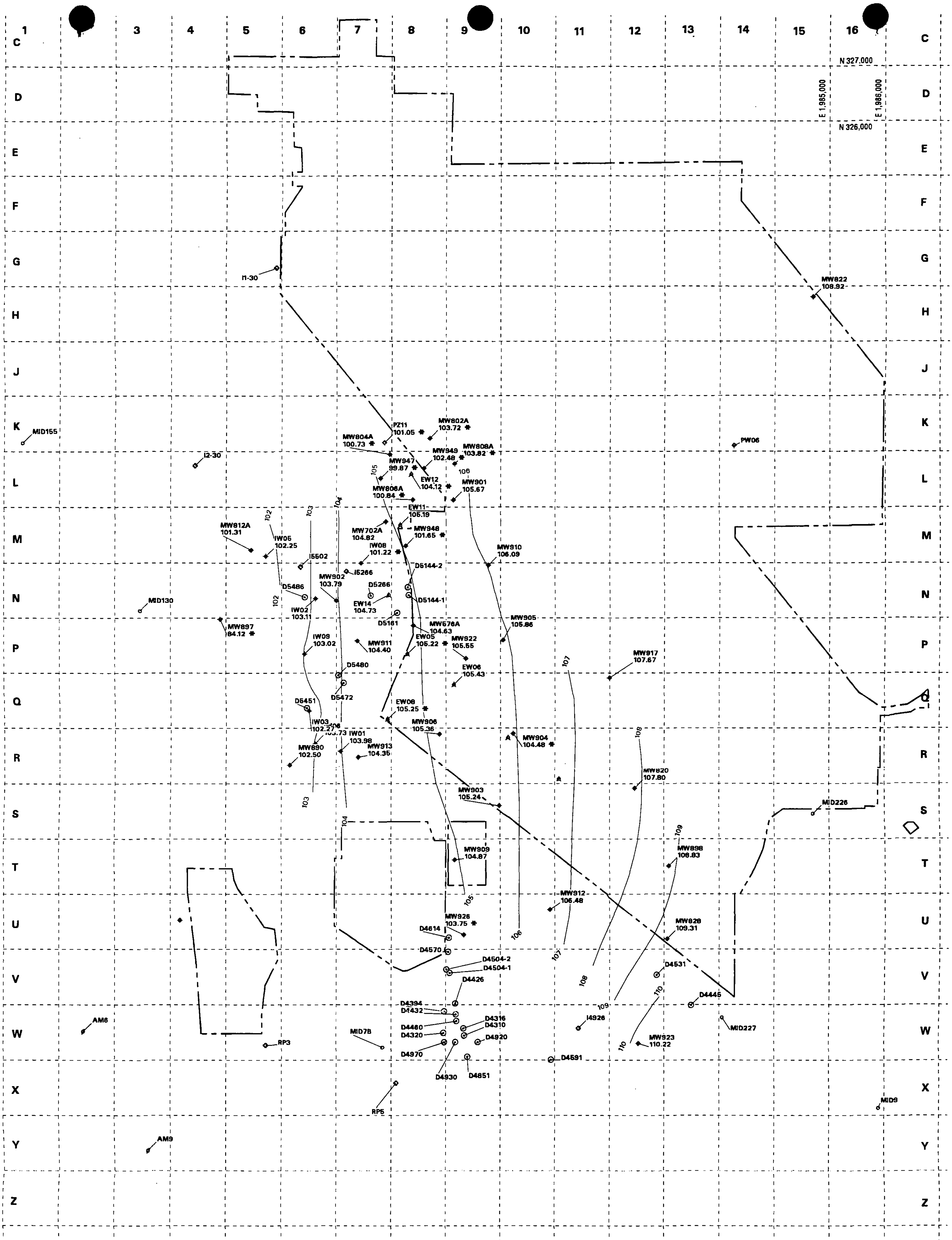
Scale in Feet 1:20400

Groundwater Elevation Contours, Second Quarter 1998
Shallow Hydrostratigraphic Zone

Five-Year Review
Castle Airport

11/11/98 lo /mnt1/gis/castle/ltgsp98/gwec2.aml 27-K725-01 Q298swtc.map

FIGURE 3-3



LEGEND

MW001	Monitoring well	
D4740	Domestic well	
PW15	Production well	
I1-01	Irrigation well-private	
MID1	Irrigation well-public	
EW01	Extraction well	
JI6	Injection well	
AM11	Municipal well	
PZ03	Piezometer	

Property boundary

Groundwater elevation contours in feet above mean sea level; dashed where inferred

Well location with groundwater elevation data

* Data not used in contouring

N

0 1700

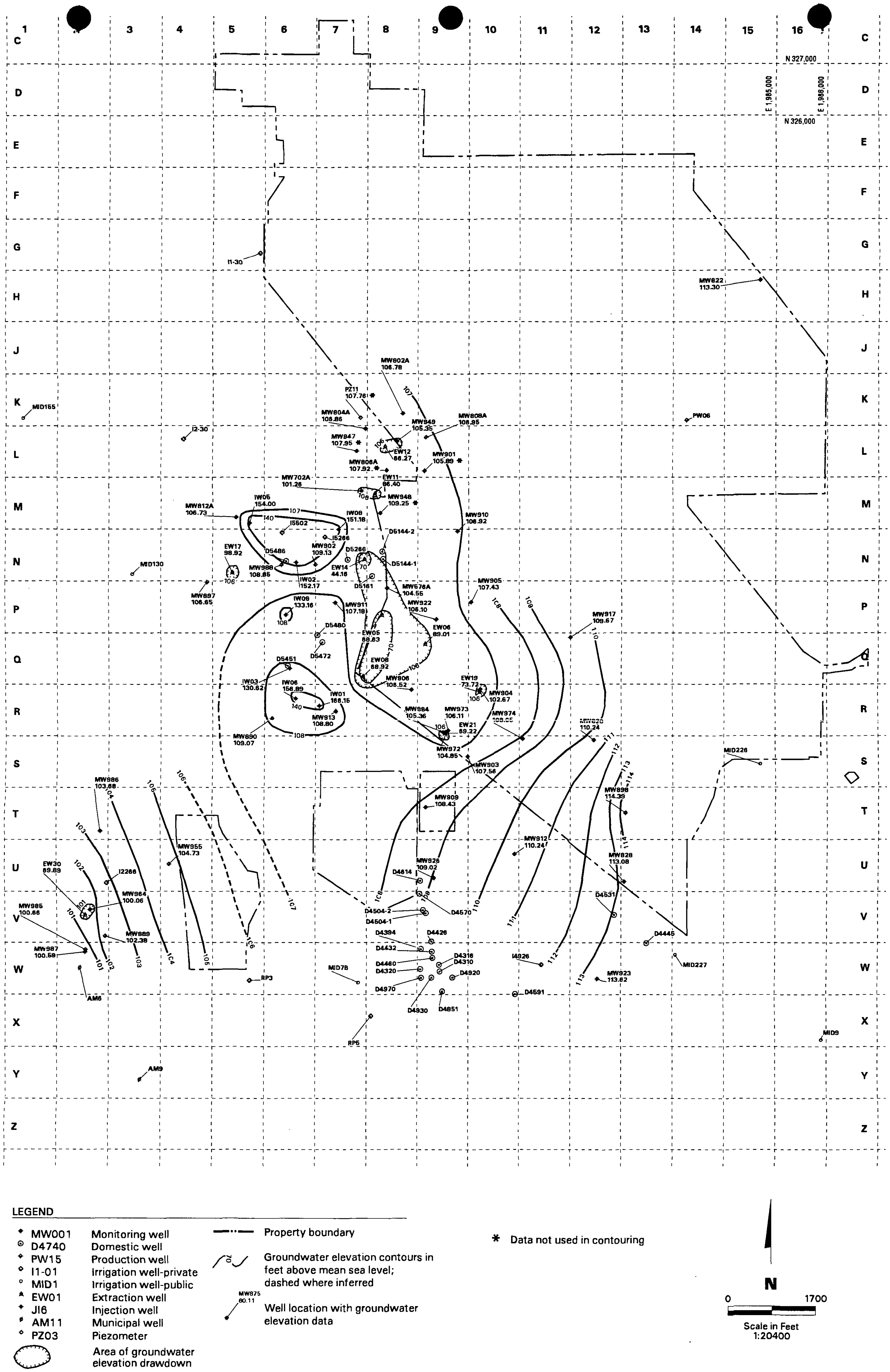
Scale in Feet
1:20400

Groundwater Elevation Contours, Fourth Quarter 1996
Upper Subshallow Hydrostratigraphic Zone

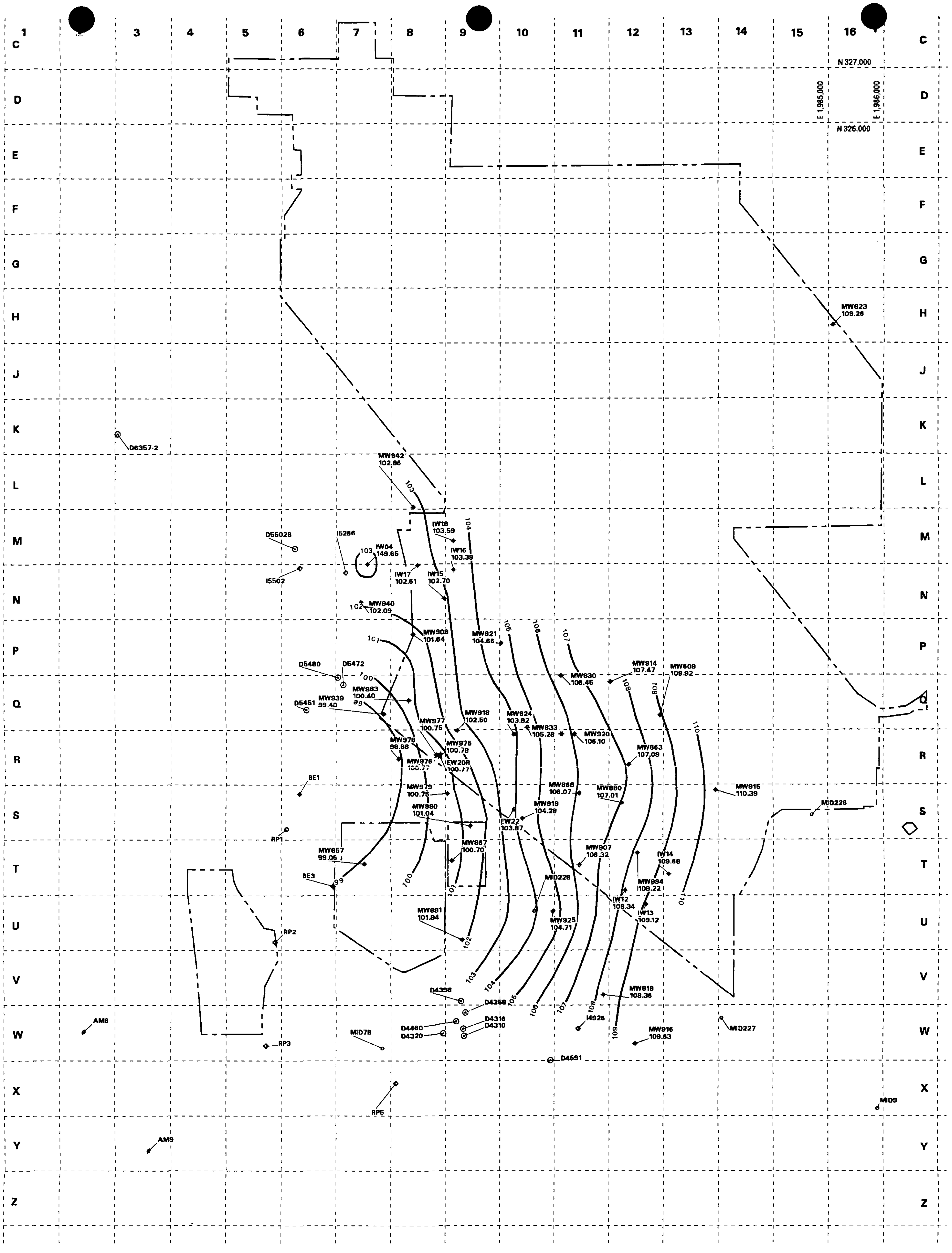
Five-Year Review
Castle Airport

03/24/98 lo /mnt1/gis/castle/ltgsp/lt_wtc2.aml 21-K725-01 Q496usswtc.map

FIGURE 3-4



Groundwater Elevation Contours, Second Quarter 1998
Upper Subshallow Hydrostratigraphic Zone
Five-Year Review
Castle Airport



LEGEND

MW001	Monitoring well	Property boundary	
D4740	Domestic well	Groundwater elevation contours in feet above mean sea level	
PW15	Production well		
I1-01	Irrigation well-private		
MID1	Irrigation well-public	Well location with groundwater elevation data	MW875 60.11
EW01	Extraction well		
JI6	Injection well		
AM11	Municipal well		

* Data not used in contouring

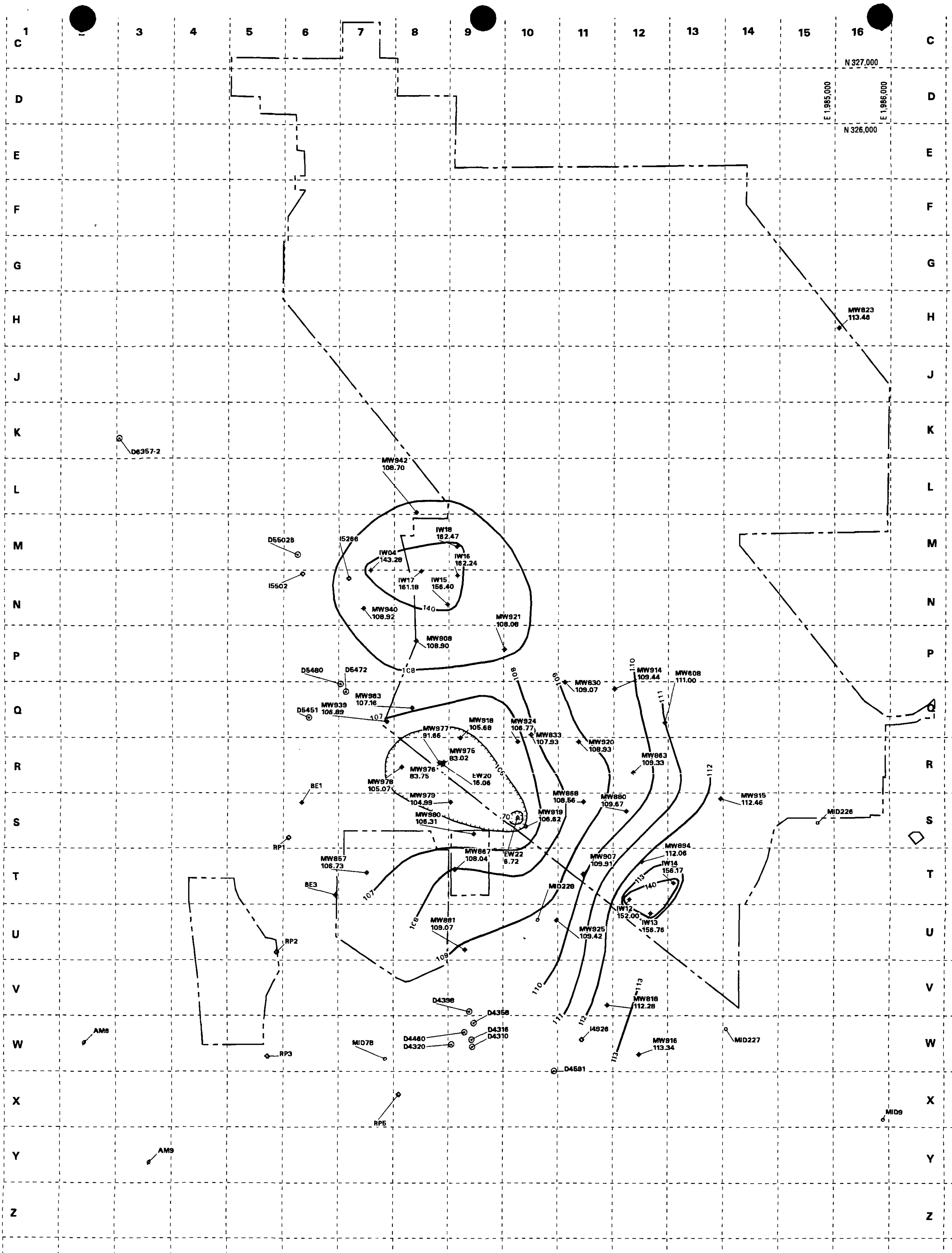
N

0 1700

Scale in Feet
1:20400

Groundwater Elevation Contours, Fourth Quarter 1997
Lower Subshallow Hydrostratigraphic Zone

Five-Year Review
Castle Airport



LEGEND

MW001	Monitoring well		Property boundary
D4740	Domestic well		Groundwater elevation contours in feet above mean sea level
I1-01	Irrigation well-private		
MID1	Irrigation well-public		
EW01	Extraction well	MW875 60.11	Well location with groundwater elevation data
JI6	Injection well		
AM11	Municipal well		

Area of groundwater elevation drawdown

N

0 1700

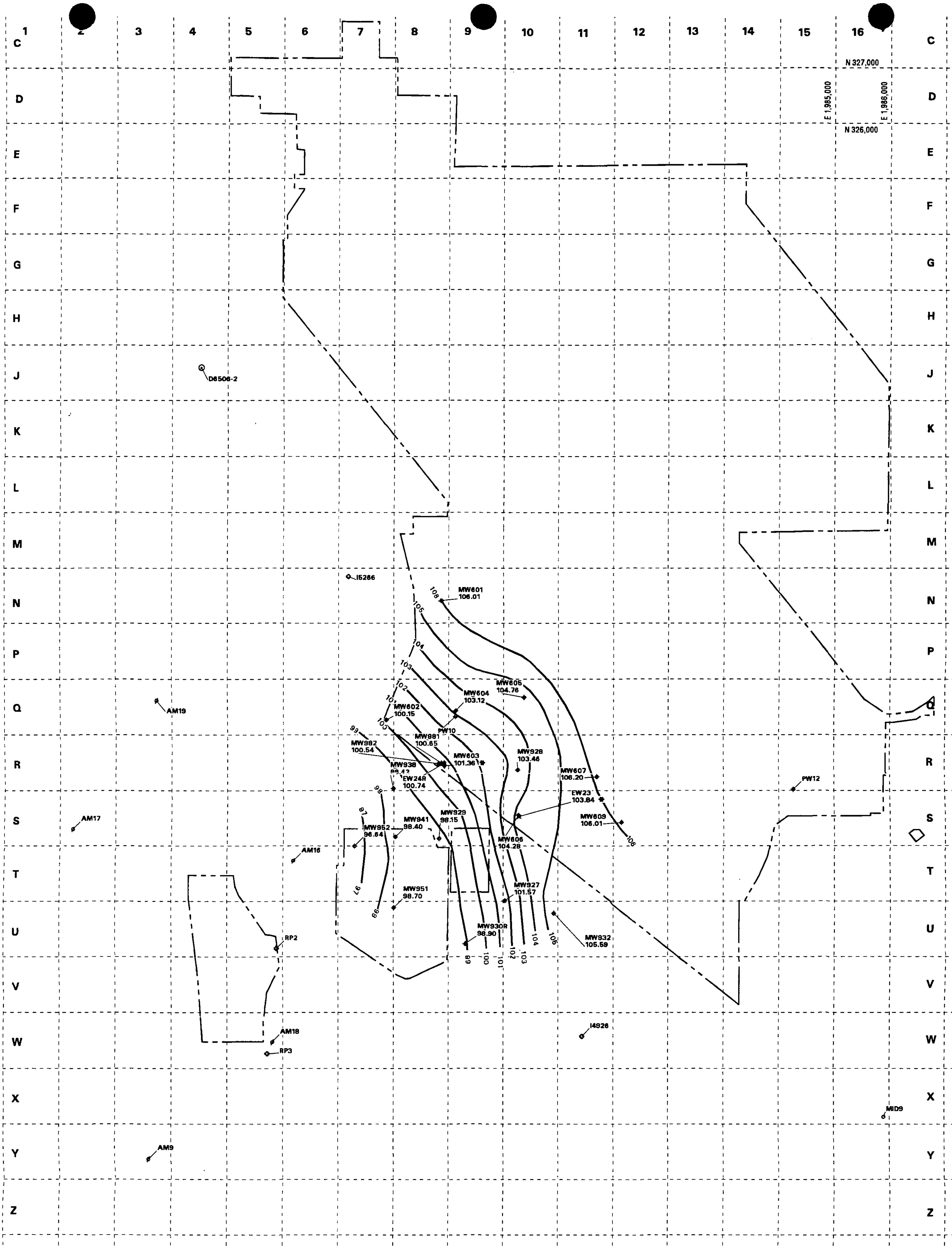
Scale in Feet
1:20400

Groundwater Elevation Contours, Second Quarter 1998
Lower Subshallow Hydrostratigraphic Zone

Five-Year Review
Castle Airport

11/11/98 lo /mnt1/gis/castle/ltgsp98/gwec2.aml 27-K725-01 Q298lsswtc.map

FIGURE 3-7



LEGEND

MW001	Monitoring well		Property boundary
D4740	Domestic well		Groundwater elevation contours in feet above mean sea level
PW15	Production well		
I1-01	Irrigation well-private	MW875 60.11	Well location with groundwater elevation data
MID1	Irrigation well-public		
AM11	Municipal well		
EW01	Extraction well		

* Data not used in contouring

N

0 1700

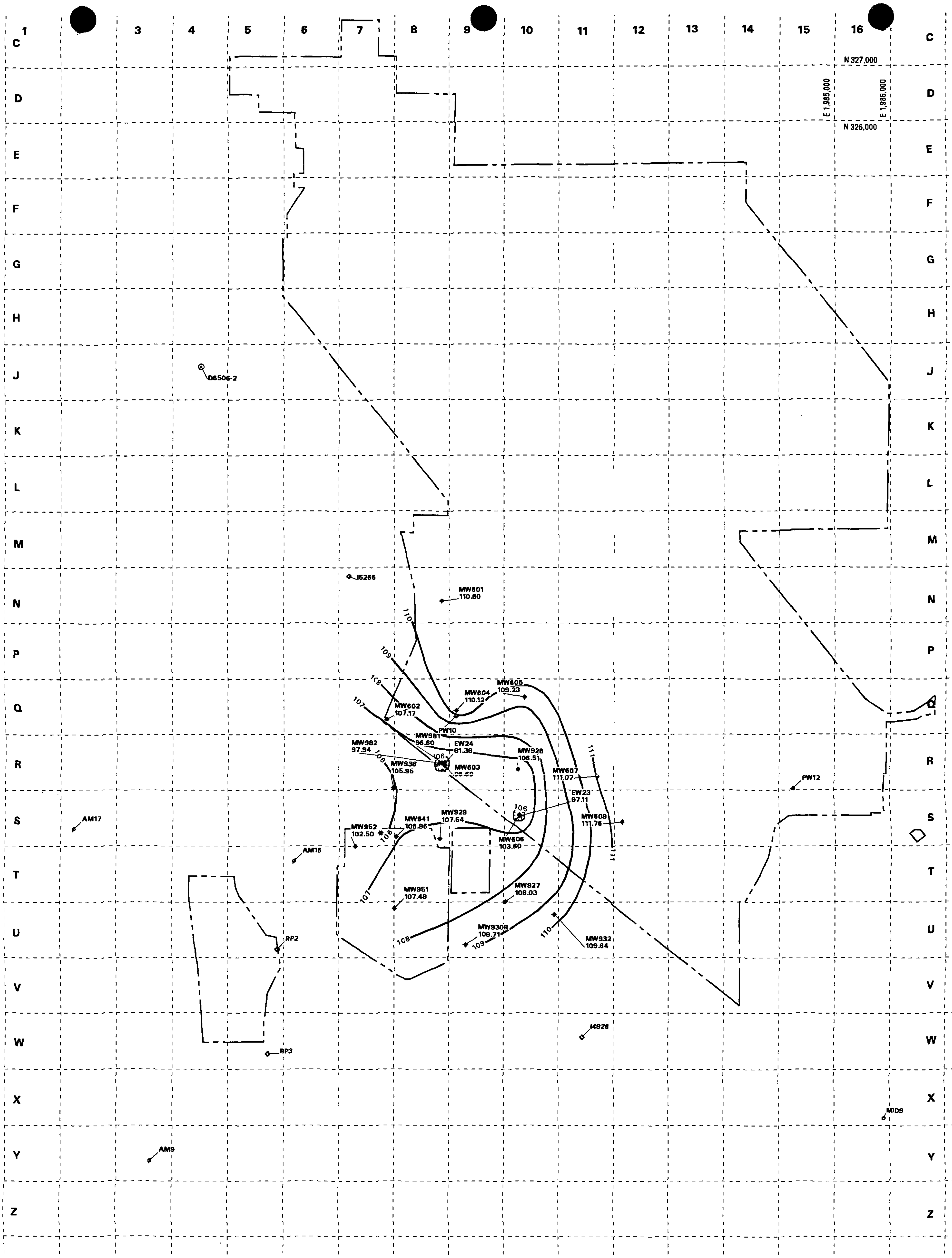
Scale in Feet
1:20400

Groundwater Elevation Contours, Fourth Quarter 1997
Confined Hydrostratigraphic Zone

Five-Year Review
Castle Airport

11/11/98 lo /mnt1/gis/castle/ltgsp97/p2_wtc.aml 27-K72901 Q497cf5gw.map

FIGURE 3-8



LEGEND

MW001	Monitoring well	
D4740	Domestic well	
PW15	Production well	
I1-01	Irrigation well-private	
MID1	Irrigation well-public	
AM11	Municipal well	
EW01	Extraction well	

Property boundary

Groundwater elevation contours in feet above mean sea level

MW875 60.11 Well location with groundwater elevation data

Area of groundwater elevation drawdown

* Data not used in contouring

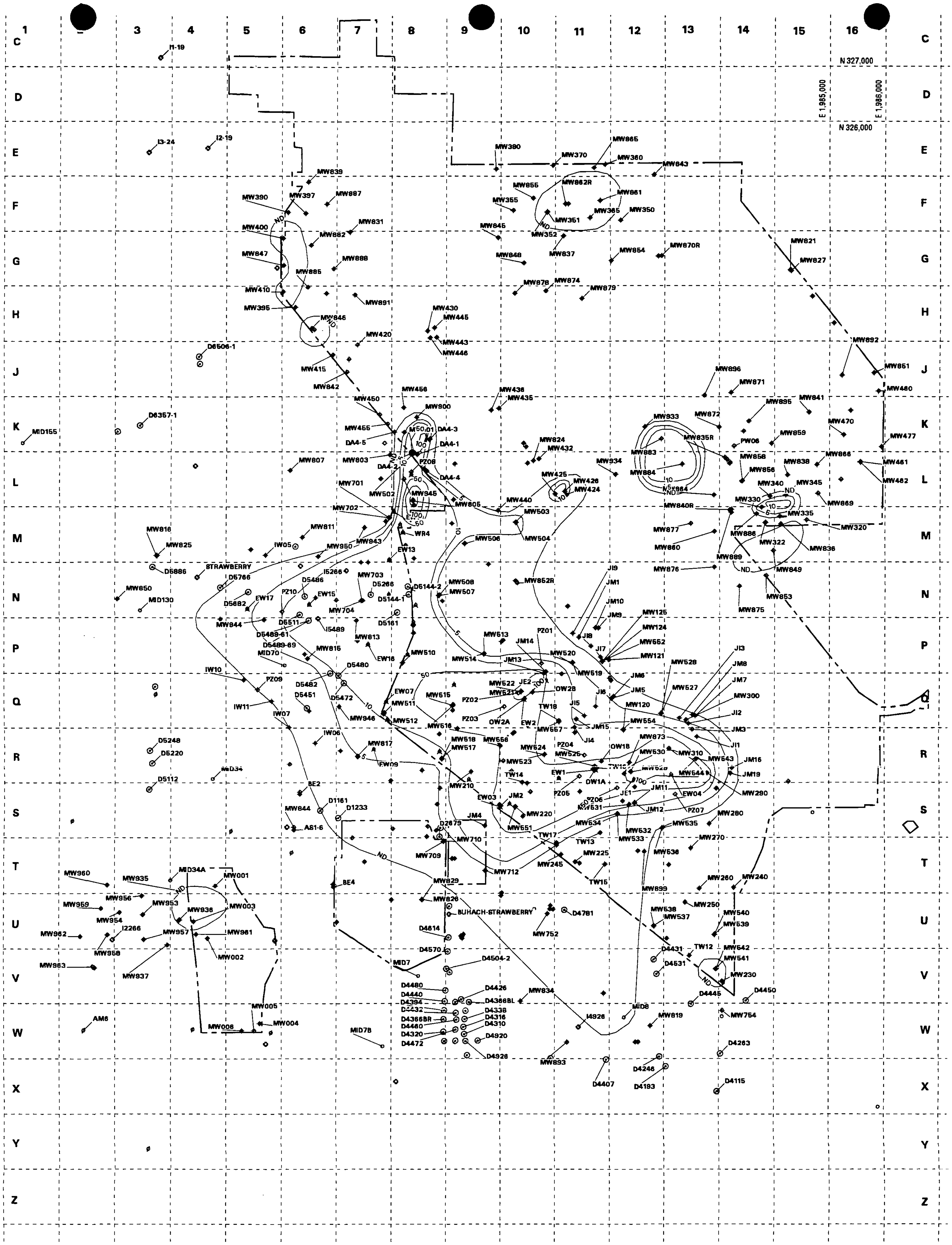
N

0 1700

Scale in Feet
1:20400

Groundwater Elevation Contours, Second Quarter 1998
Confined Hydrostratigraphic Zone

Five-Year Review
Castle Airport



LEGEND

- MW001 Monitoring well
- D4740 Domestic well
- PW15 Production well
- I1-01 Irrigation well-private
- MID1 Irrigation well-public
- EW01 Extraction well
- JI6 Injection well
- AM11 Municipal well
- PZ03 Piezometer

Property boundary

Isoconcentration contour of TCE in $\mu g/L$

N

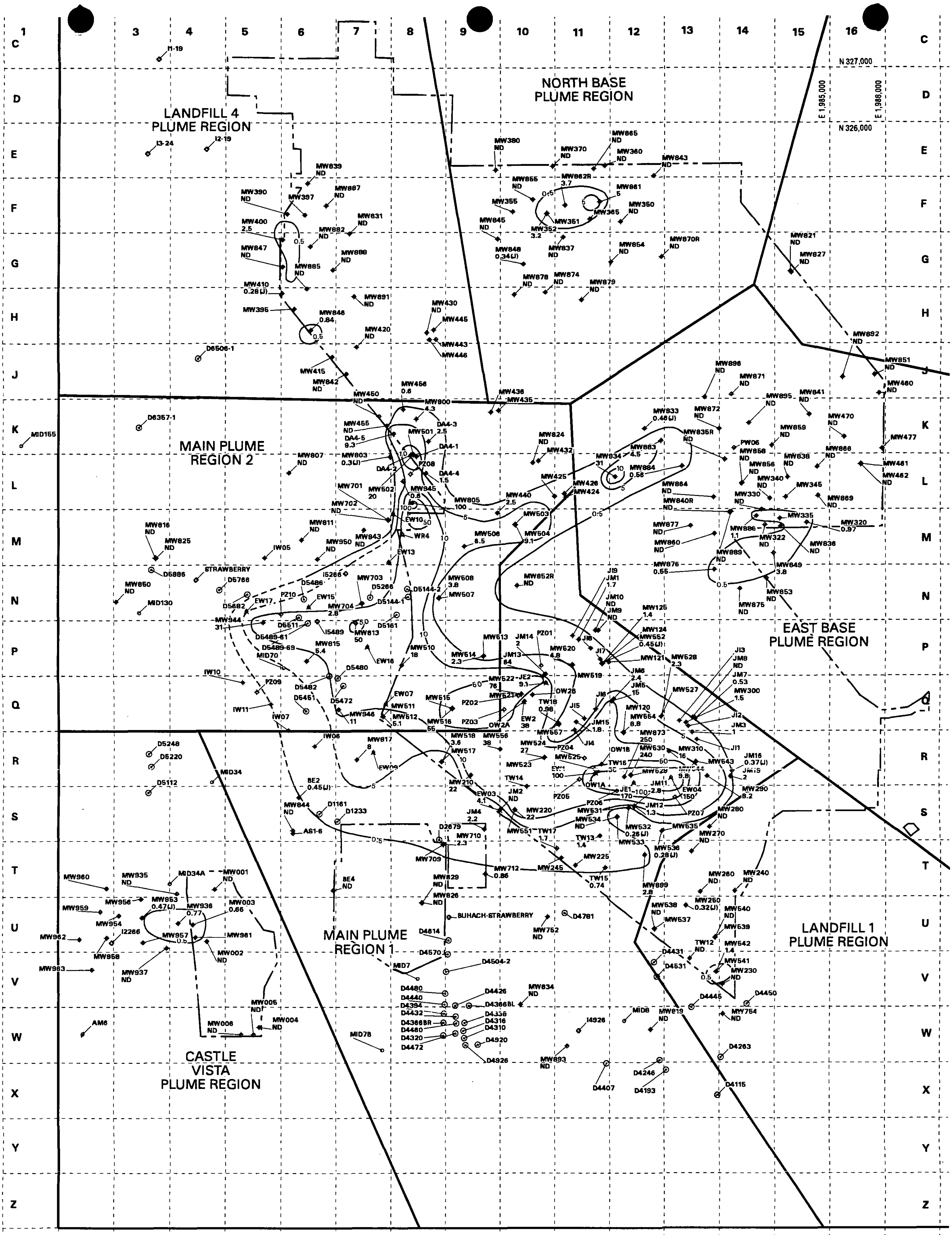
0 1700

Scale in Feet
1:20400

Note: Map recreated from old map; Well TCE concentration data unable to be duplicated

TCE Plume Delineation Map, Third Quarter 1994
Shallow Hydrostratigraphic Zone

Five-Year Review
Castle Airport



LEGEND

MW001	Monitoring well	
D4740	Domestic well	
PW15	Production well	
I1-01	Irrigation well-private	
MID1	Irrigation well-public	
EW01	Extraction well	
JI6	Injection well	
AM11	Municipal well	
PZ03	Piezometer	

Property boundary

Isoconcentration contour of TCE in µg/L; dashed where inferred

MW875 6.4 Well location with TCE concentration in µg/L; data in brown represent sample results from current quarter

(J) Estimated Value Due to Trace Concentration or Quality Control Deficiency

N

0 1700

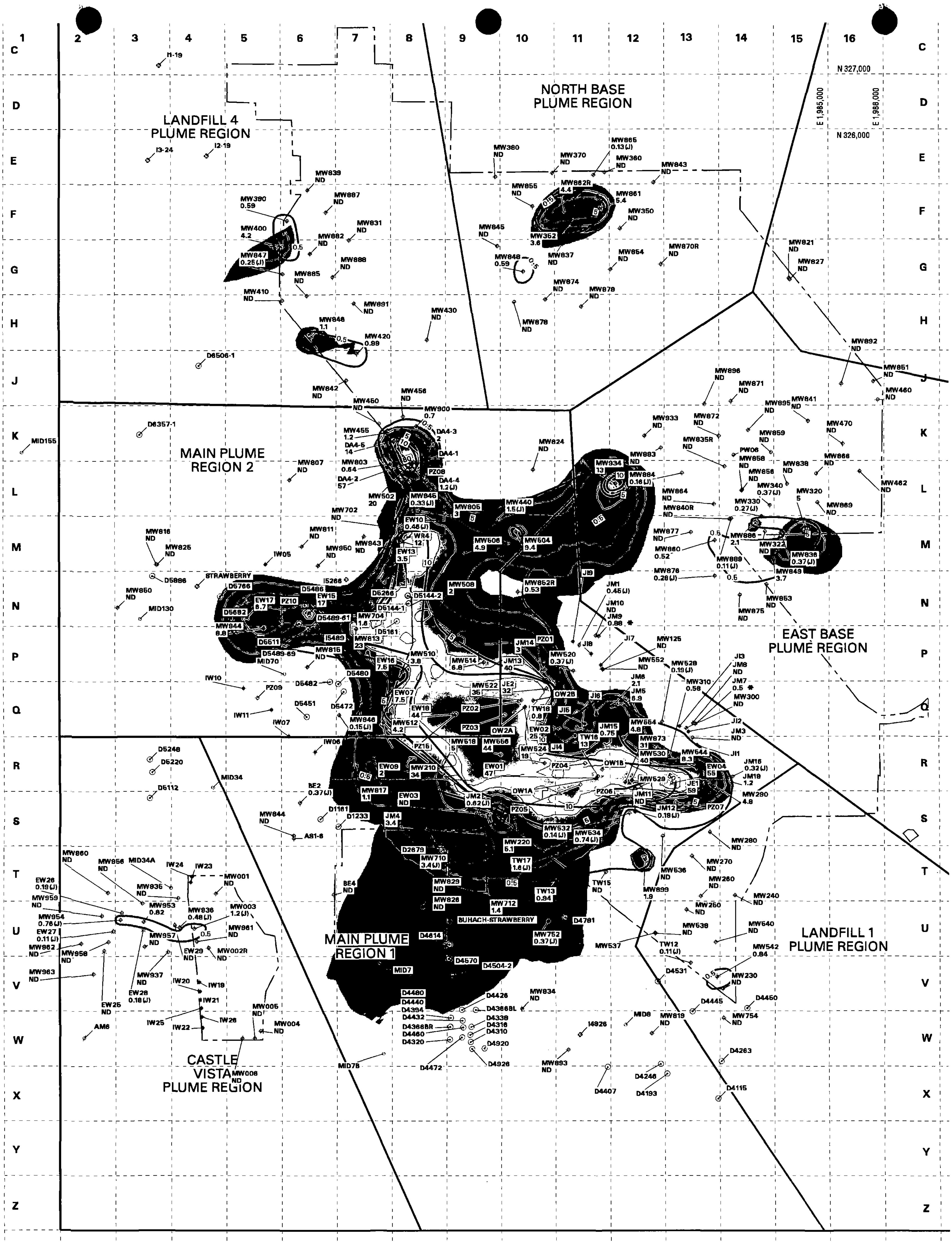
Scale in Feet
1:20400

TCE Plume Delineation Map, Fourth Quarter 1996
Shallow Hydrostratigraphic Zone

Five-Year Review
Castle Airport

11/11/98 lo ../gis/castle/ltgsp/lt_tce2.aml 21-K725-01 Q496stce.map

FIGURE 3-11



LEGEND

MW001	Monitoring well	Property boundary	
D4740	Domestic well	Hand-drawn isoconcentration contour of TCE in μg/L	
PW15	Production well		
I1-01	Irrigation well-private	3-D isoconcentration contour of TCE in μg/L	
MID1	Irrigation well-public		
EW01	Extraction well		
JI6	Injection well		
AM11	Municipal well	Well location with TCE concentration in μg/L; data in brown represent sample results from current quarter	MW875 8.4
PZ03	Piezometer		

(J) Estimated value due to trace concentration or quality control deficiency

* Data not used for hand-drawn contours

N

0 1700

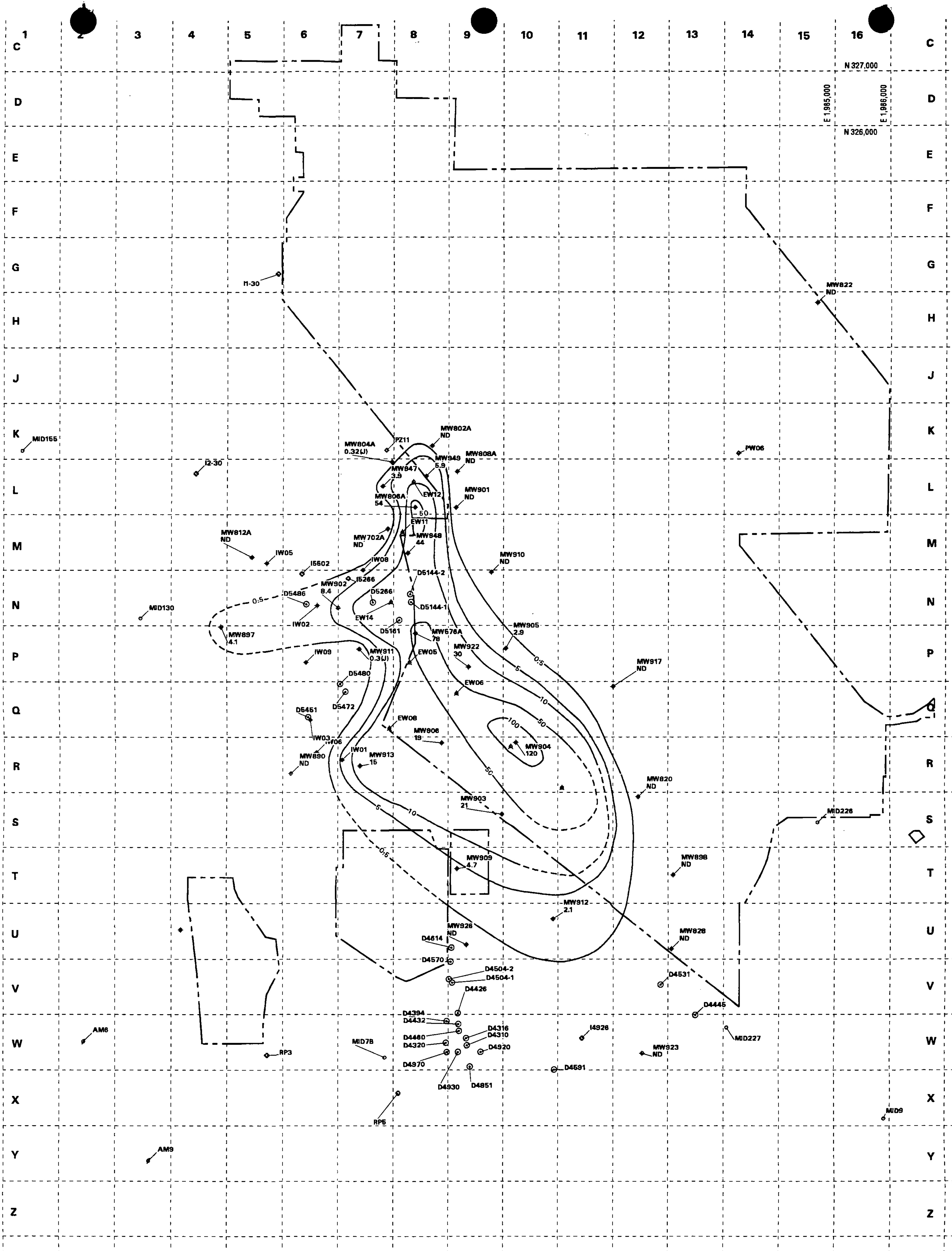
Scale in Feet
1:20400

0.1 μg/L 0.3 μg/L 1 μg/L 3 μg/L 10 μg/L 30 μg/L 100 μg/L

TCE Plume Delineation Map, Second Quarter 1998
Shallow Hydrostratigraphic Zone
Five-Year Review
Castle Airport

11/11/98 lo /mnt1/gis/castle/ltgsp98/tce_evs_plume.aml 27-K725-01 q298stce_evs.map

FIGURE 3-12



LEGEND

- MW001 Monitoring well
- D4740 Domestic well
- PW15 Production well
- I1-01 Irrigation well-private
- MID1 Irrigation well-public
- EW01 Extraction well
- JI6 Injection well
- AM11 Municipal well
- PZ03 Piezometer

Property boundary

Isoconcentration contour of TCE in μg/L; dashed where inferred

Well location with TCE concentration in μg/L; data in brown represent sample results from current quarter

(J) Estimated Value Due to Trace Concentration or Quality Control Deficiency

N

0 1700

Scale in Feet

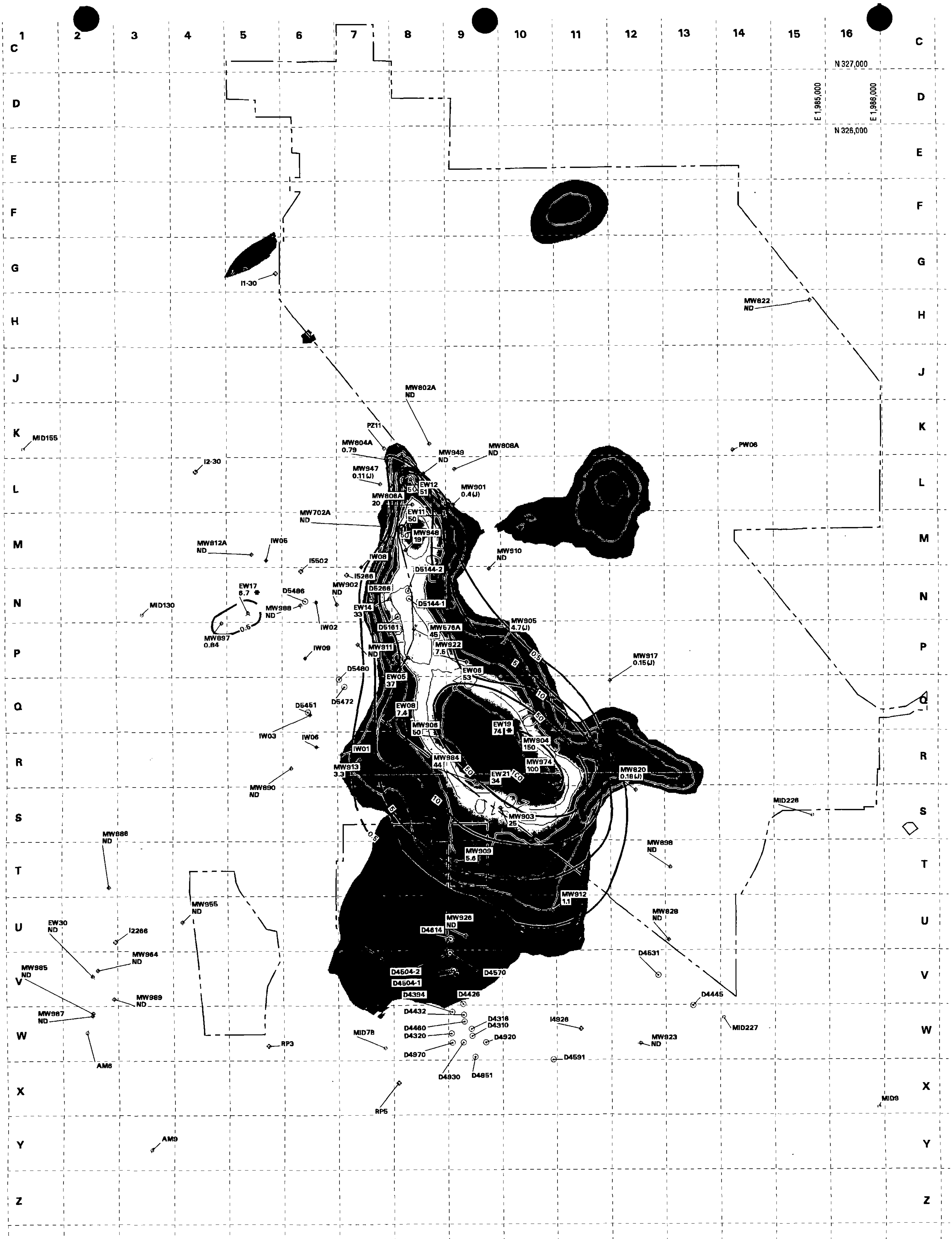
1:20400

TCE Plume Delineation Map, Fourth Quarter 1996
Upper Subshallow Hydrostratigraphic Zone

Five-Year Review
Castle Airport

11/11/98 lo ../gis/castle/ltgsp/lt_tce2.aml 21-K725-01 Q496usstce.map

FIGURE 3-13



LEGEND

MW001	Monitoring well	
D4740	Domestic well	
PW15	Production well	
I1-01	Irrigation well-private	
MID1	Irrigation well-public	
EW01	Extraction well	
JI6	Injection well	
AM11	Municipal well	
PZ03	Piezometer	

Property boundary

Hand-drawn isoconcentration contour of TCE in µg/L

3-D isoconcentration contour of TCE in µg/L

MW875 6.4 Well location with TCE concentration in µg/L; data in brown represent sample results from current quarter

(J) Estimated value due to trace concentration or quality control deficiency

* Data not used for hand-drawn contours

N

0 1700

Scale in Feet
1:20400

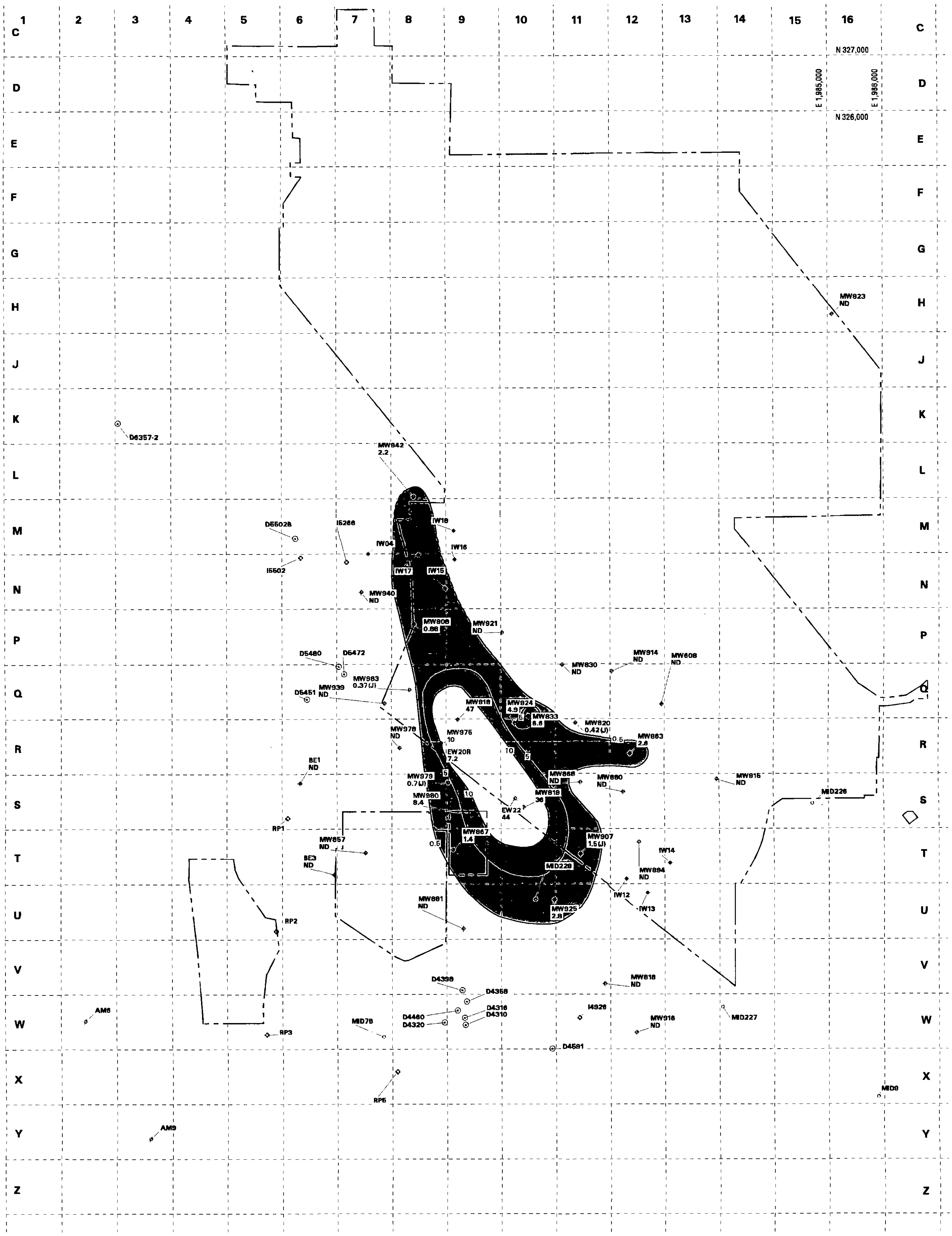
0.1 µg/L 0.3 µg/L 1 µg/L 3 µg/L 10 µg/L 30 µg/L 100 µg/L

TCE Plume Delineation Map, Second Quarter 1998
Upper Subshallow Hydrostratigraphic Zone

Five-Year Review
Castle Airport

11/11/98 lo /mnt1/gis/castle/ltgsp98/tce_evs_plume.aml 27-K725-01 q298usstce_evs.map

FIGURE 3-14



LEGEND

MW001	Monitoring well		Property boundary
D4740	Domestic well		
PW15	Production well	50	Isoconcentration contour of TCE in μg/L; dashed where inferred
I1-01	Irrigation well-private		
MID1	Irrigation well-public		
EW01	Extraction well	MW875 6.4	Well location with TCE concentration in μg/L; data in brown represent sample results from current quarter
JI6	Injection well		
AM11	Municipal well		

(J) Estimated value due to trace concentration or quality control deficiency

N

0 1700

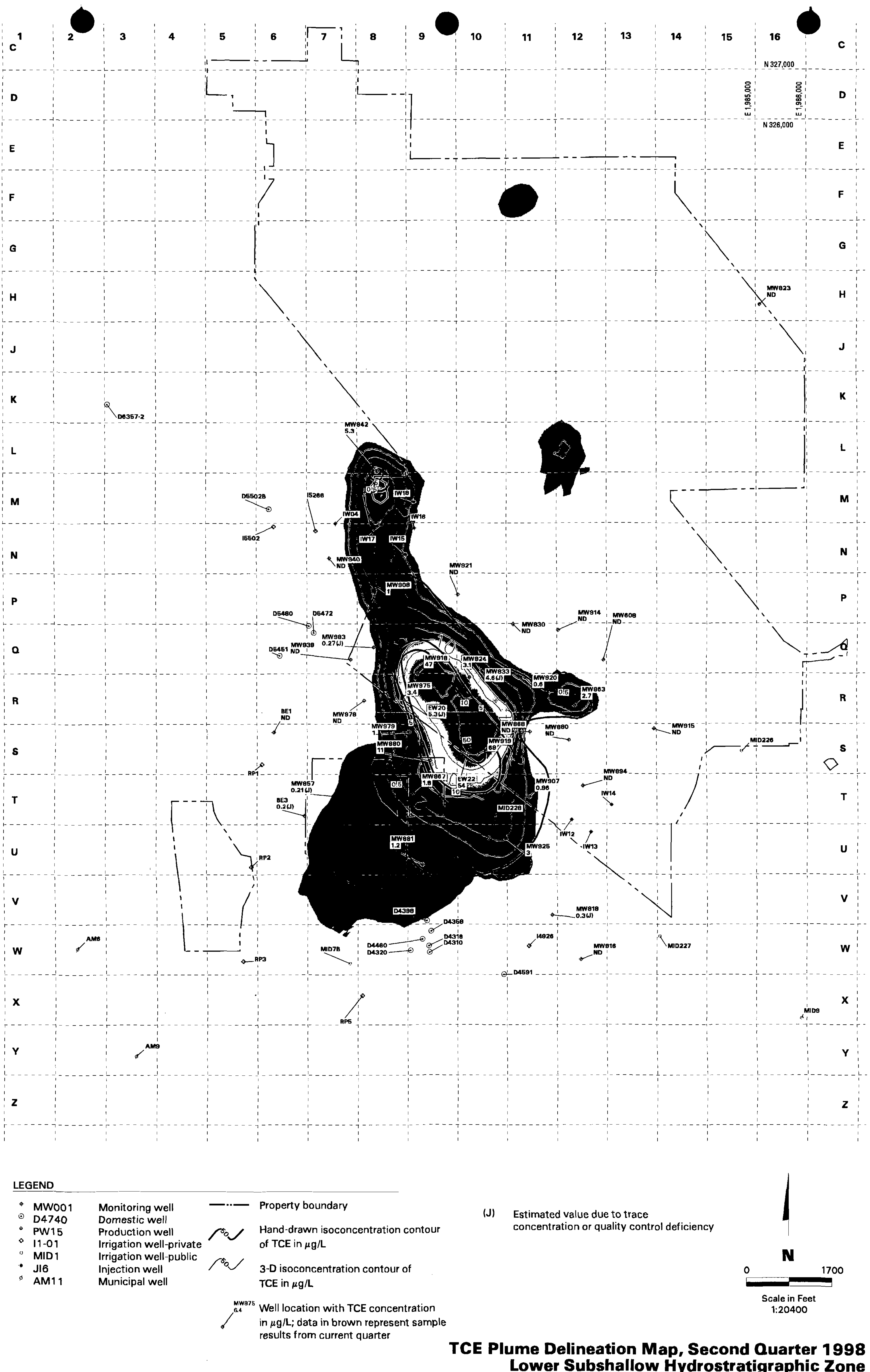
Scale in Feet
1:20400

1/2 - 5 μg/L of TCE
5 - 10 μg/L of TCE
10 - 50 μg/L of TCE
50 - 100 μg/L of TCE
100 + μg/L of TCE

TCE Plume Delineation Map, Fourth Quarter 1997
Lower Subshallow Hydrostratigraphic Zone
Five-Year Review
Castle Airport

11/11/98 lo /mnt1/gis/castle/ltgsp97/p2_tce.aml 27-K72901 Q497lss5tce.map

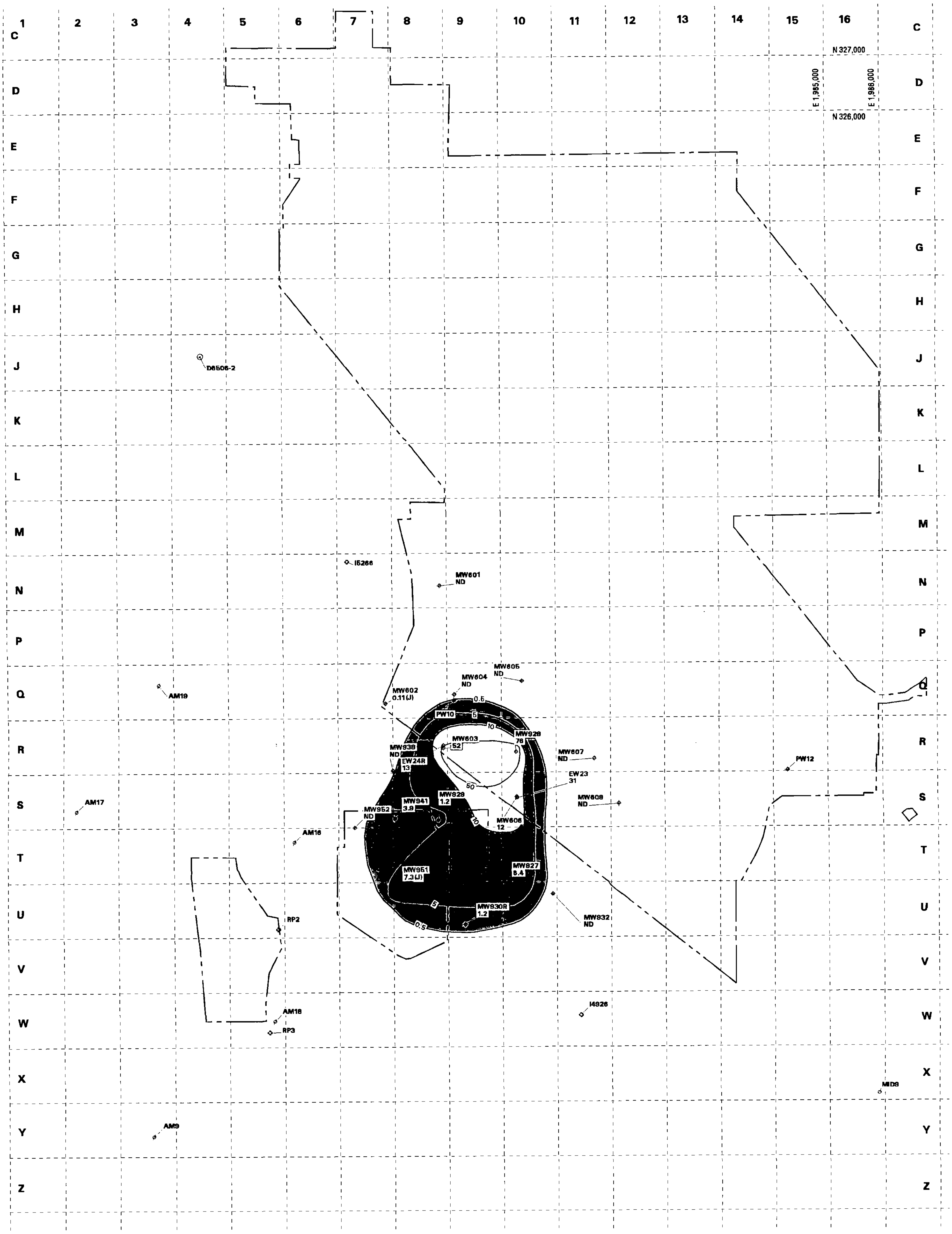
FIGURE 3-15



TCE Plume Delineation Map, Second Quarter 1998
Lower Subshallow Hydrostratigraphic Zone
Five-Year Review
Castle Airport

11/11/98 lo /mnt1/gis/castle/ltgsp98/tce_evs_plume.aml 27-K725-01 q298lsstce_evs.map

FIGURE 3-16



LEGEND

MW001	Monitoring well	Property boundary
D4740	Domestic well	
PW15	Production well	Isoconcentration contour of TCE in μg/L; dashed where inferred
I1-01	Irrigation well-private	
MID1	Irrigation well-public	
AM11	Municipal well	MW875 6.4 Well location with TCE concentration in μg/L; data in brown represent sample results from current quarter
EW01	Extraction well	

(J) Estimated value due to trace concentration or quality control deficiency

N

0 1700

Scale in Feet
1:20400

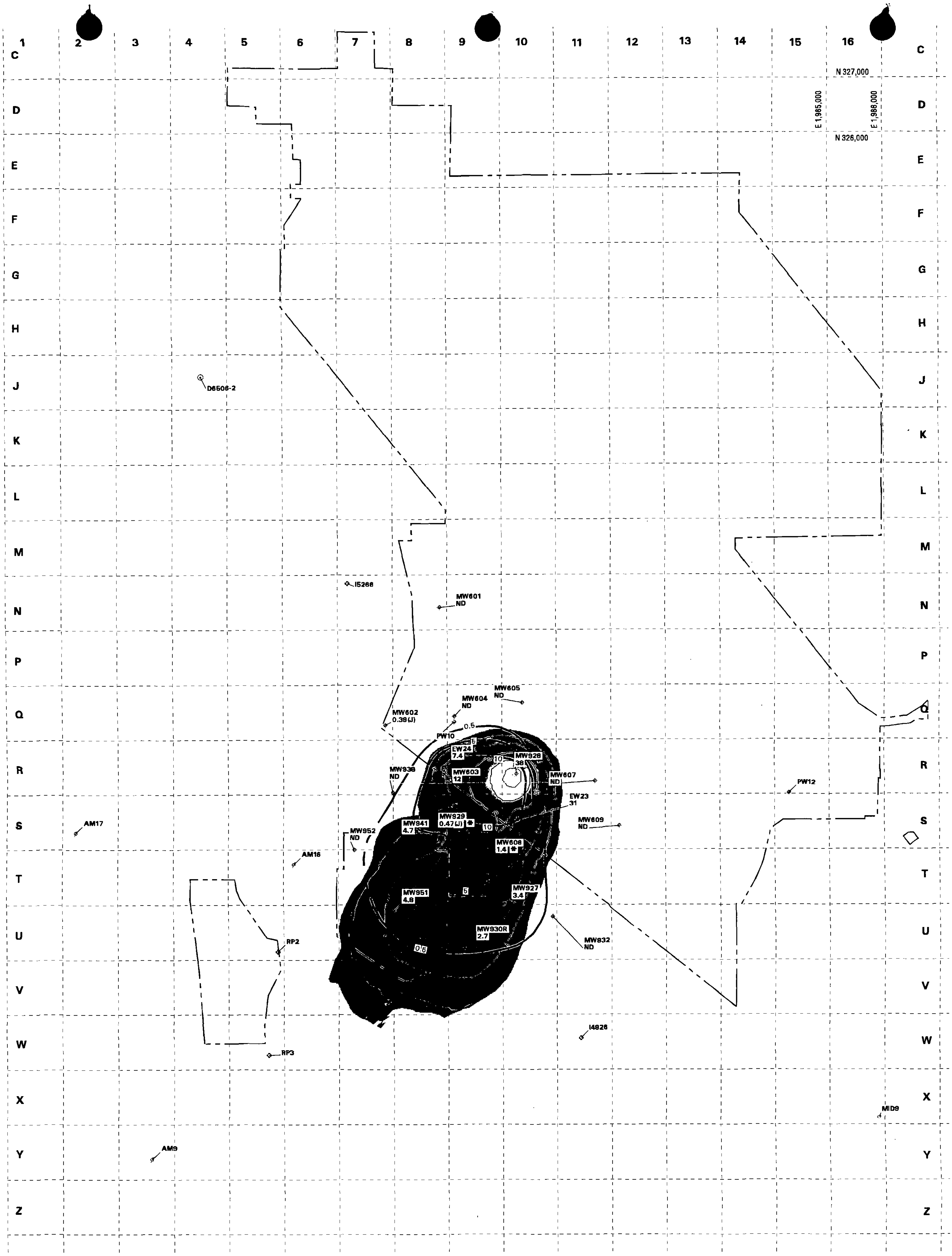
- 1/2 - 5 μg/L of TCE
- 5 - 10 μg/L of TCE
- 10 - 50 μg/L of TCE
- 50 - 100 μg/L of TCE
- 100 + μg/L of TCE

TCE Plume Delineation Map, Fourth Quarter 1997
Confined Hydrostratigraphic Zone

Five-Year Review
Castle Airport

11/11/98 lo /mnt1/gis/castle/ltgsp97/p2_tce.aml 27-K72901 Q497cf5tce.map

FIGURE 3-17



LEGEND

MW001	Monitoring well		Property boundary
D4740	Domestic well		Hand-drawn isoconcentration contour of TCE in μg/L
PW15	Production well		
I1-01	Irrigation well-private		3-D isoconcentration contour of TCE in μg/L
MID1	Irrigation well-public		
AM11	Municipal well		
EW01	Extraction well		

MW875 6.4 — Well location with TCE concentration in μg/L; data in brown represent sample results from current quarter

(J) Estimated value due to trace concentration or quality control deficiency

* Data not used for hand-drawn contours

N

0 1700

Scale in Feet
1:20400

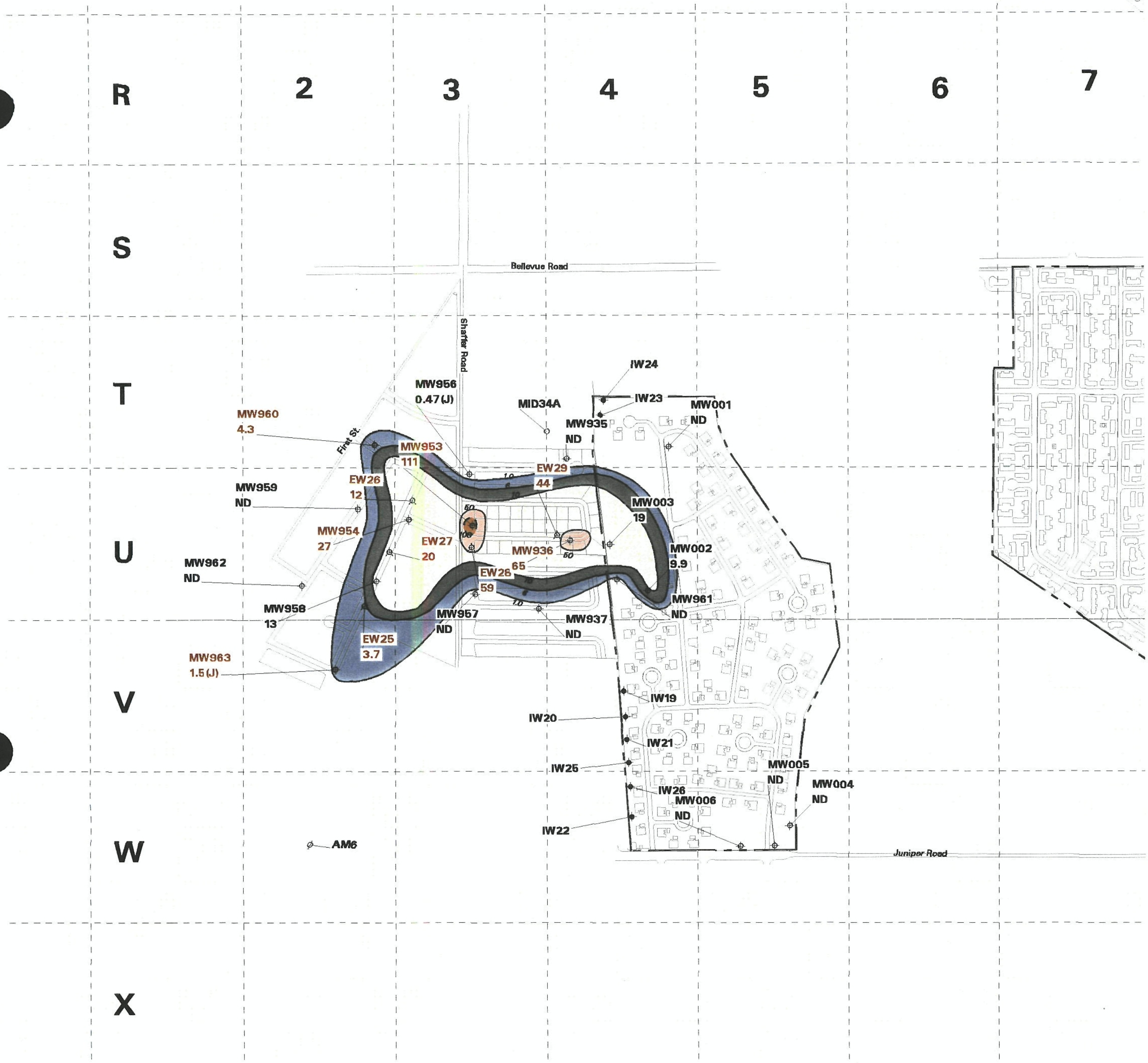
0.1 μg/L 0.3 μg/L 1 μg/L 3 μg/L 10 μg/L 30 μg/L 100 μg/L

TCE Plume Delineation Map, Second Quarter 1998
Confined Hydrostratigraphic Zone

Five-Year Review
Castle Airport

11/11/98 lo /mnt1/gis/castle/ltgsp98/tce_evs_plume.aml 27-K725-01 q298cftce_evs.map

FIGURE 3-18



LEGEND

MW001	Monitoring well	
MID1	Irrigation well-public	
EW01	Extraction well	
JI6	Injection well	
AM11	Municipal well	

Property boundary

Isoconcentration contour of *cis* -1,2-DCE in µg/L

MW958 13 Well location with *cis* -1,2-DCE concentrations in µg/L; data in brown represent sample results from current quarter

0.5 - 6 µg/L of *cis*-1,2-DCE
6 - 10 µg/L of *cis*-1,2-DCE
10 - 50 µg/L of *cis*-1,2-DCE
50 + µg/L of *cis*-1,2-DCE

N

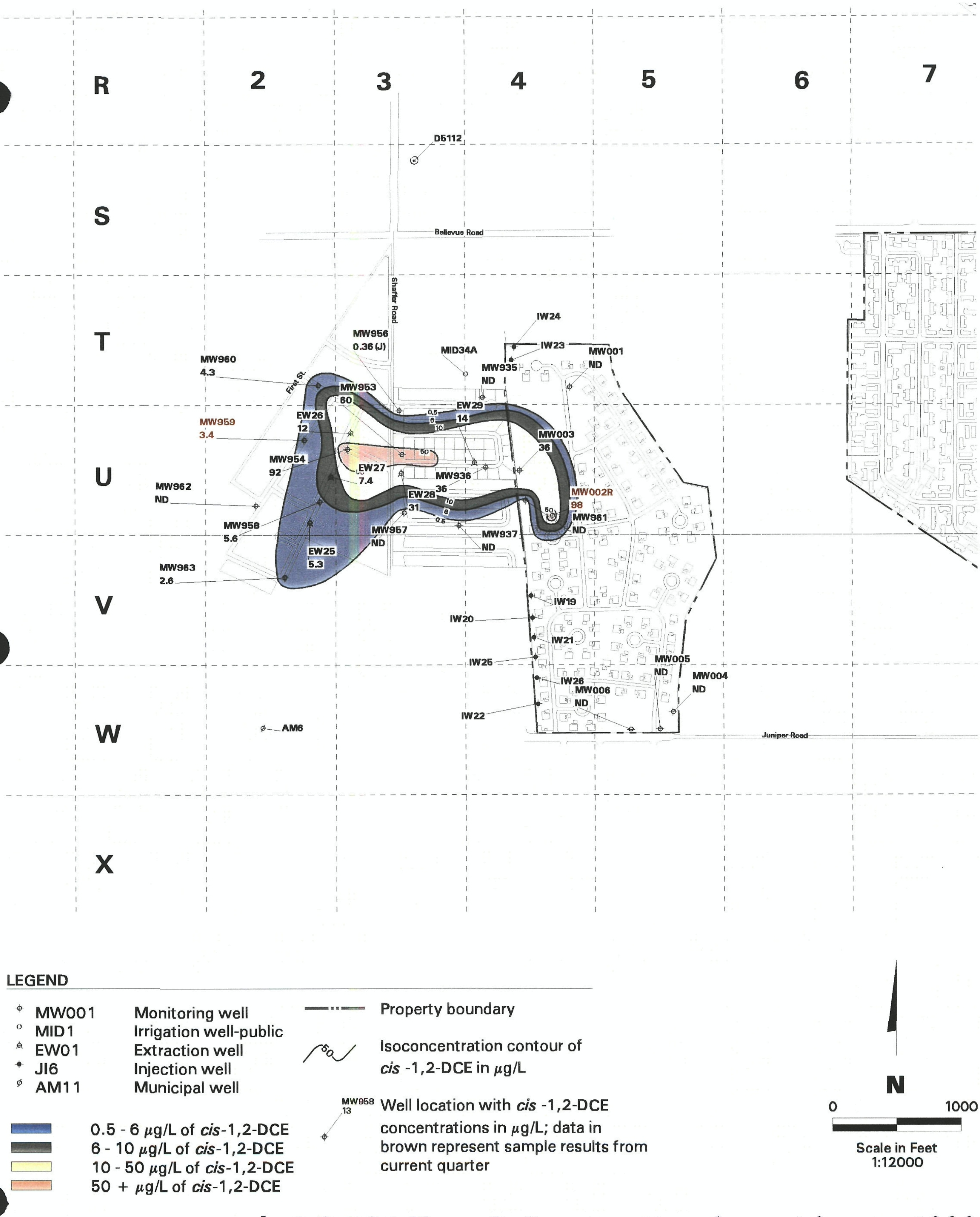
0 1000

Scale in Feet
1:12000

(J) Estimated value due to trace concentration or quality control deficiency

cis-1,2-DCE Plume Delineation Map, Fourth Quarter 1997
Shallow Hydrostratigraphic Zone

Five-Year Review
Castle Airport



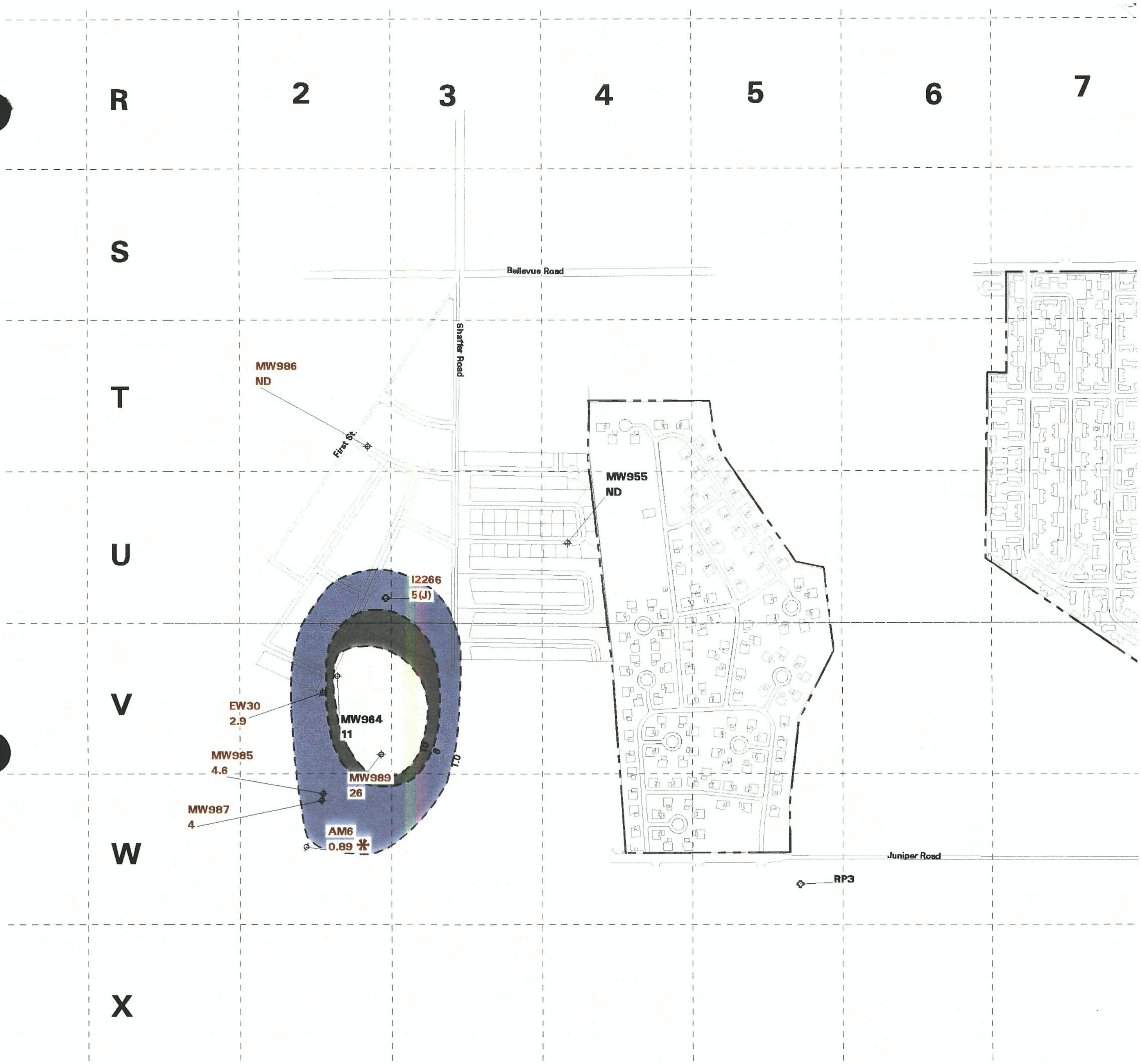
(J) Estimated value due to trace concentration or quality control deficiency

cis -1,2-DCE Plume Delineation Map, Second Quarter 1998
Shallow Hydrostratigraphic Zone

Five-Year Review
Castle Airport

11/11/98 lo /users/lorlando/gis/castle/teer/dce_plume_teer.aml 27-K725-01 Q298sdce.map

FIGURE 3-20



LEGEND

MW001	Monitoring well		Property boundary	*	Data not used in contouring
I1-01	Irrigation well-private				
AM11	Municipal well	50	Isoconcentration contour of *cis* -1,2-DCE in μg/L		
EW01	Extraction well				

0.5 - 6 μg/L of *cis*-1,2-DCE
6 - 10 μg/L of *cis*-1,2-DCE
10 - 50 μg/L of *cis*-1,2-DCE
50 + μg/L of *cis*-1,2-DCE

MW958
13
Well location with *cis* -1,2-DCE concentrations in μg/L; data in brown represent sample results from current quarter

N

0 1000

Scale in Feet
1:12000

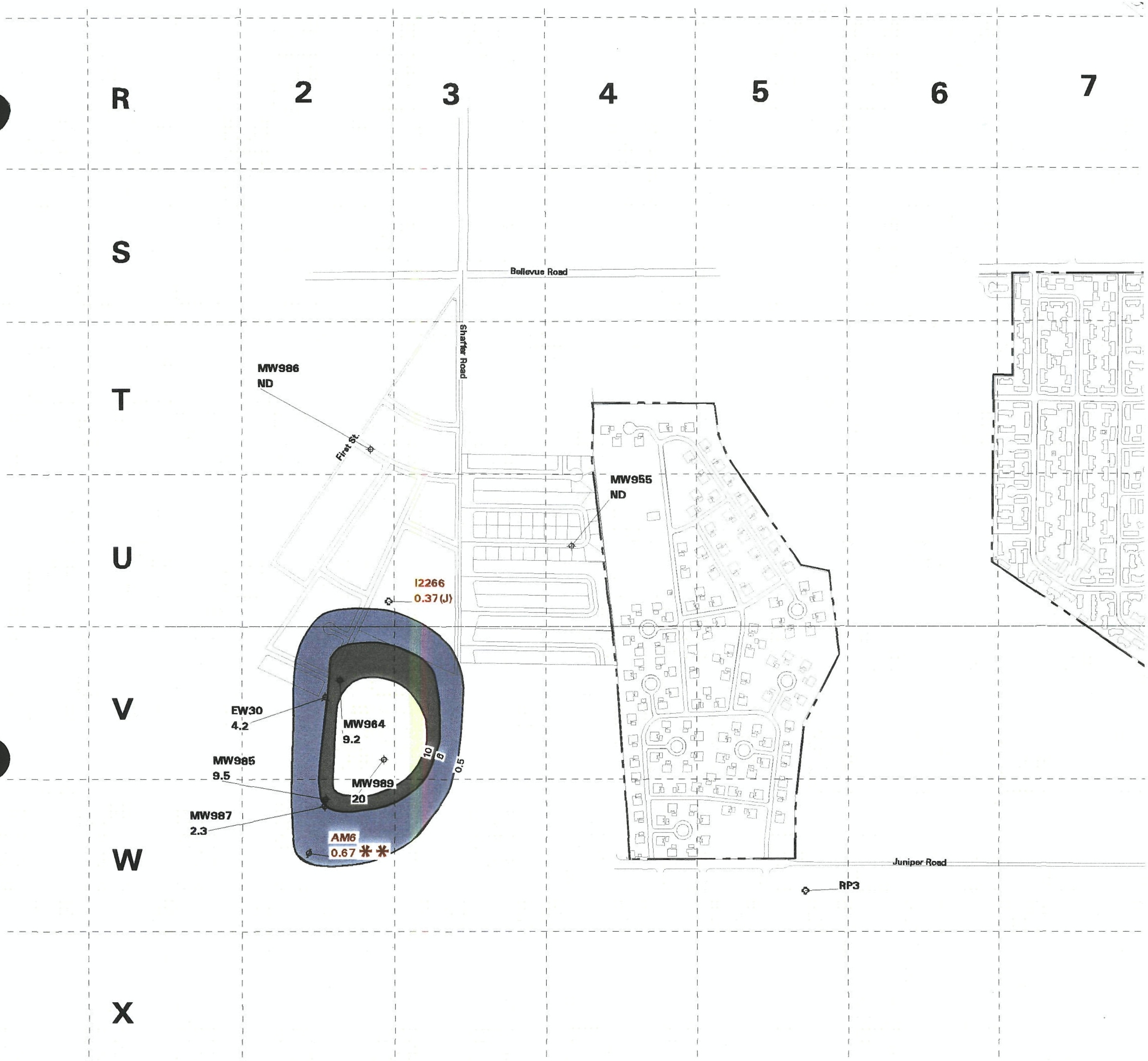
(J) Estimated value due to trace concentration or quality control deficiency

cis-1,2-DCE Plume Delineation Map, Fourth Quarter 1997
Upper Subshallow Hydrostratigraphic Zone

Five-Year Review
Castle Airport

11/11/98 lo /users/lorlando/gis/castle/teer/dce_plume_teer.aml 27-K725-01 Q497ussdce.map

FIGURE 3-21



LEGEND

MW001	Monitoring well		Property boundary	* *	Well screened in Shallow, Upper Subshallow, and Lower Subshallow hydrostratigraphic zones
I1-01	Irrigation well-private	50	Isoconcentration contour of *cis* -1,2-DCE in µg/L		
AM11	Municipal well	MW958 13	Well location with *cis* -1,2-DCE concentrations in µg/L; data in brown represent sample results from current quarter		
EW01	Extraction well				

0.5 - 6 µg/L of *cis*-1,2-DCE
6 - 10 µg/L of *cis*-1,2-DCE
10 - 50 µg/L of *cis*-1,2-DCE
50 + µg/L of *cis*-1,2-DCE

N

0 1000

Scale in Feet
1:12000

(J) Estimated value due to trace concentration or quality control deficiency

cis -1,2-DCE Plume Delineation Map, Second Quarter 1998
Upper Subshallow Hydrostratigraphic Zone

Five-Year Review
Castle Airport

11/11/98 lo /users/lorlando/gis/castle/teer/dce_plume_teer.aml 27-K725-01 Q298ussdce.map

FIGURE 3-22

4. REMEDIAL OBJECTIVES

The following sections summarize the objectives of the remedial actions at Castle Airport as stated in the applicable RODs (CB-Part 1 ROD; SCOU ROD [when final]). The operational history of ongoing remedial actions are briefly discussed and the effectiveness of the remedial systems in achieving the performance levels established in the applicable ROD is evaluated.

4.1 CB-PART 1 ROD

The final CB-Part 1 (Groundwater) ROD for Castle Airport was issued by the Air Force on 31 January 1997. The signatures of all parties (USAF, EPA, California EPA) were obtained by 5 June 1997. The following statements and information concerning remedial objectives for groundwater at Castle Airport are extracted from the Declaration for the Record of Decision (Section 2.0) of the final CB-Part 1 ROD (USAF, 1997).

The stated objective of CB-Part 1 remedial actions is "to capture the contaminated groundwater plume(s) within the Maximum Contaminant Level (MCL) boundary of the most restrictive contaminant present, and clean up the groundwater to MCL levels." The CB-Part 1 ROD supersedes all previous groundwater RODs, i.e., the OU-1 Interim ROD and the OU-2 Final ROD. The ongoing and planned actions under these two prior RODs are integrated into the selected remedy for the comprehensive cleanup of groundwater contamination at Castle Airport.

The selected remedy for the Main Base Plume consists of plume capture and treatment (pump-and-treat groundwater remediation for the TCE plume) to achieve groundwater cleanup to the MCL (5 μg/L for TCE). This remedy was to be implemented in a phased approach and integrate the ongoing and planned remedial actions authorized in the OU-1 and OU-2 RODs. A phased approach was chosen in order to gain the benefit of additional technical information from operation of the OU-1 and OU-2 groundwater treatment systems and the ongoing LTGSP. This information would then be used to assess the need for and the design of subsequent system modifications/expansion. This phased approach had been developed and presented in a previous document, the Revised Basis of Design Report (RBDR) (Jacobs, 1996e).

Phase 1 involved modifying the existing OU-1 system (completed in 1996) to better remove TCE and control migration of TCE "hot spots" in the Shallow HSZ. Phase 1 also included constructing and operating the OU-2 system to control migration of the northern portion of the plume and to remove contaminants from the Shallow and USS HSZs. Phase 2 involved construction of an additional treatment plant and extraction/injection wells to enhance the OU-1 and OU-2 systems' effectiveness by addressing groundwater contamination in the deeper HSZs (USS, LSS, and Confined). Data resulting from operation of Phase 1 and Phase 2 systems and monitoring results from the LTGSP will then be used to assess the need for and the design of Phase 3. Phase 3 will add any remedial system components necessary to fully achieve the overall objectives of the CB-Part 1 ROD for groundwater remediation at Castle Airport.

Site characterization data sufficient to select a final remedy for the Castle Vista Plume were not available when the CB-Part 1 ROD was published. A presumptive remedy of groundwater pump-and-treat is stated. This remedy, equivalent to that for the Main Base Plume, would involve capturing the contaminant plume (*cis*-1,2-DCE) and remediating the groundwater to MCL levels (6 μg/L for *cis*-1,2-DCE). The CB-Part-1 ROD states that for the Castle Vista Plume, further analysis will be conducted to verify the appropriateness of MCLs as cleanup levels and to verify that the cleanup levels are consistent with Section IIIG of State Water Resources Control Board (SWRCB) Resolution No. 92-49 (SWRCB, 1994).

Discharge standards for treated groundwater were also established in the CB-Part 1 ROD. These standards, as modified by a Memorandum of Non-Significant Changes to Record of Decision for CB-Part 1 Groundwater—Final, dated 9 December 1997, are listed in Table 4-1. The 30-day median standard for discharge of the primary contaminants (TCE and *cis*-1,2-DCE) and for most other VOCs is 0.5 μg/L (USAF, 1997).

The following sections summarize the status and performance of the operational groundwater treatment systems at Castle Airport in view of the objectives of the CB-Part 1 ROD.

4.1.1 OU-1

The following subsections summarize the objectives, status, and performance to date of the OU-1 groundwater treatment system.

4.1.1.1 OU-1 Interim ROD/CB-Part 1 ROD

The stated objective of the OU-1 Interim ROD was to address the remediation of groundwater contamination at Castle Airport by eliminating or reducing the risks posed by the site, through treatment and engineering and institutional controls (USAF, 1991). The major components of the selected interim remedy, the OU-1 groundwater treatment system, were:

- Pump groundwater from a series of shallow extraction wells to maintain hydraulic control of the plume and begin reducing residual TCE concentrations.
- Surface treat the extracted groundwater by air stripping to allow the return of water to beneficial use (resource recovery).
- Reinject the treated groundwater back to the shallow aquifer (Shallow HSZ) to assist in maintaining hydraulic control and to avoid depletion of the aquifer.
- Apply natural biological enhancement to accelerate the degradation of hazardous constituents in the saturated zone.
- Abate the air stripper emissions with GAC to avoid degrading ambient air quality.

All of the listed components of the OU-1 Interim ROD are compatible with the more general objectives of the CB-Part 1 ROD, which has superseded the OU-1 ROD. It is noted that programs to enhance natural biological activity in the saturated zone were never implemented at Castle Airport. A bench-scale study conducted in 1994 demonstrated that conditions at Castle Airport were not favorable for bio-enhancement (PRC, 1994). An explanation of significant difference (ESD) regarding the non-implementation of biological enhancement was submitted on 28 August 1996 (USAF, 1996). It is further noted that GAC initially was used to abate air stripper emissions, but was taken off-line on 11 March 1996 because VOC air emissions were less than the 2.0 lb/day and thus, met the emission standards of the local air quality district. An ESD regarding discontinuation of vapor phase treatment of air stripper emissions was submitted on 28 August 1996 (USAF, 1996). This ESD was combined with the ESD on non-implementation of biological enhancement and approved by the regulatory agencies during September 1996.

Standards for groundwater cleanup were not established in the OU-1 Interim ROD but were set as MCLs (5 μg/L for TCE) in the CB-Part 1 ROD. Standards for treated groundwater were originally set at MCLs in the OU-1 Interim ROD. Prior to construction and operation of the OU-1 system, these standards were changed to values compatible with those subsequently incorporated in the CB-Part 1 ROD (30-day median of 0.5 μg/L for TCE).

4.1.1.2 OU-1 Operational History and Performance Assessment

The OU-1 groundwater treatment system was placed in operation on 29 July 1994 and, through Q2/98, has been in operation for approximately three years, 10 months. The location and design of the OU-1 system was described in Section 2.3.2.1. Significant milestones/events during the operational history of the OU-1 system are:

- 29 July 1994—system placed in operation.
- March 1995—system operation reduced to single air stripping tower.
- September–November 1995—TCE concentration in final effluent exceeds treatment standard (0.5 μg/L).
- 12 December 1995—system shut down due to TCE concentration in effluent.
- 3 January 1996—system resumes automatic operation using both air stripping towers.
- 11 January 1996—Air Force receives Notice of Violation from EPA.
- 19 January 1996—Problem Analysis Report on TCE in effluent submitted to Air Force and subsequently to regulatory agencies.
- 11 March 1996—carbon adsorption and solvent recovery unit taken off line because air emissions were lower than local emission limits.
- March–May 1996—system expansion and enhancement: added one extraction well (EW04) and seven piezometers and reconfigured plant operations and software to reduce risk of plant shutdown from flooding.
- 28 August 1996—Air Force submits explanation of significant difference regarding vapor phase treatment and biological enhancement.

- 14 August 1998—TCE concentration in final effluent exceeds treatment standard (0.5 μg/L).

An operational summary of the OU-1 groundwater treatment system is provided in Table 4-2. The table lists monthly values (except for first two quarters of operation) for average flow rate, total water treated, plant downtime, influent TCE concentration, mass of TCE removed, and mass of TCE released to the atmosphere. Through June of 1998, the plant has treated a total of approximately 617 million gallons of groundwater and has removed approximately 444 pounds of TCE from the Main Base Plume (Shallow HSZ).

The influent TCE concentration has declined from an average of approximately 115 μg/L during the first six months of system operation to an average of approximately 49 μg/L during the most recent six months of operation. Correspondingly, the mass of TCE removed has declined from an average of approximately 11 pounds per month to an average of approximately 6.2 pounds per month, while the amount of water treated has increased from an average of approximately 12.2 million gallons per month to an average of approximately 15.2 million gallons per month. Cumulative TCE removed and water treated and monthly values for TCE removed and water treated by the OU-1 groundwater treatment system are shown on Figure 4-1.

Hydraulic (water level) effects in the Shallow HSZ resulting from OU-1 groundwater treatment system operation can be seen by comparing the groundwater elevation contours shown on Figure 3-1 (Q3/94 - just prior to system startup) with those shown on Figure 3-3 (Q2/98). The changes in the area of greatest influence of the OU-1 system (grid locations Q11-13, R11-13, and S11-13) are very distinct. Localized mounds and depressions have been created in the water table and the general direction of groundwater flow has shifted from westerly to more northwesterly, reducing the potential for continuing plume migration beyond the boundaries of Castle Airport. It should be noted that the OU-2 and Phase 2 systems were also operational during a portion of this period. OU-2 extraction and injection wells are all located a significant distance to the north and west of the OU-1 system and only one Phase 2 extraction well (EW18) is completed in the Shallow HSZ.

The effects of OU-1 system operation on the Main Base Plume in the Shallow HSZ can be seen by comparing TCE concentration contours shown on Figure 3-10 (Q3/94) with those shown on Figure 3-12 (Q2/98). A noticeable decrease in the areas of highest TCE concentration is apparent. Figure 4-2 shows the estimated extent of hydraulic capture in the Shallow HSZ as of Q2/98. This figure documents that the OU-1 system (grid locations as above), operating in concert with OU-2 and Phase 2, is providing hydraulic control of the Main Base Plume in the Shallow HSZ and is capturing contaminated groundwater within the 5 μg/L contour (MCL for TCE) as required by the CB-Part 1 ROD. Groundwater modeling results and subsequent monitoring results (Q3/98), not presented in this report but presented in the draft TEER (Jacobs, 1998b), confirm these results. Although superseded, these results also meet all objectives of the original OU-1 Interim ROD.

4.1.1.3 OU-1 ARARs Review

ARARs associated with the OU-1 groundwater treatment system operation are listed in Section 4 of the CB-Part 1 ROD. Changes to these ARARs have not been requested or proposed and an ARARs review is not a standard component of a Type Ia five-year review (EPA, 1994). No changes to the OU-1 groundwater treatment system were required by changes in ARARs.

4.1.1.4 OU-1 Summary of Site Visits

The OU-1 groundwater treatment system is an ongoing remedial action. The treatment plant, extraction and injection wells, and the conveyance system (pipelines) are observed daily by contractor personnel responsible for O&M. Air Force Base Closure Agency (AFBCA) personnel with offices at Castle Airport regularly observe the system. Regulatory agency personnel typically visit Castle Airport monthly.

4.1.1.5 OU-1 Areas of Noncompliance

Operation of the OU-1 groundwater treatment system has, in general, been in compliance with requirements of the CB-Part 1 ROD. The only known specific noncompliance events occurred during all or a portion of the period from September 1995 through early December

1995, and on 14 August 1998. During both events the TCE concentration in the OU-1 plant effluent exceeded the treatment standard of 0.5 μg/L.

The first event resulted in the system being shut down from 12 December 1995 through 2 January 1996; system operation resumed on 3 January 1996. A notice of violation (NOV) was issued to the Air Force by the regulatory agencies on 11 January 1996 (EPA, 1996). A Problem Analysis Report addressing the incident was prepared and submitted to the Air Force on 19 January 1996 and subsequently submitted to the regulatory agencies on 22 January 1996. The apparent cause of the exceedance was that certain valves at the plant were not completely closed and a small amount of untreated water (approximately 1 gpm) entered the effluent stream. The Problem Analysis Report concluded that contractor procedures for review and reporting of analytical data from plant monitoring were not effective in identifying operational problems. Corrective actions initiated to eliminate the problem included a 24-hour turn-around time for plant effluent samples submitted for VOC analysis, the distribution of preliminary analytical data to a number of operations and management personnel, and revised preparation and review procedures for the monthly status reports to ensure that data tables and text are consistent.

The second event followed a brief power outage and automatic restart of the plant. Because certain program files had been lost during updates in July 1998, the air stripper blowers did not restart and appropriate interconnects were not in place to shut down the plant under these conditions. A problem analysis report was issued on 9 September 1998. This document identified several programming revisions which could be implemented to prevent a reoccurrence of the 14 August event. These corrective actions are pending. In the interim, O&M procedures have been modified such that the potential for a reoccurrence is minimized.

The combined existing remedial system for the Main Base Plume is likely not in compliance with the CB-Part 1 ROD, in that full hydraulic control of the plume in the USS, LSS, and Confined HSZs may not be achieved, at least seasonally. The OU-1 groundwater treatment system addresses only the Shallow HSZ, where full hydraulic control appears to have been achieved during all seasons as a result of the combined influence of the OU-1, OU-2, and Phase 2 groundwater treatment systems.

The combined existing remedial system for the Main Base Plume has also not met the CB-Part 1 ROD objective which stipulates cleanup of the groundwater to the MCL (TCE). This objective cannot be met until some time in the future.

4.1.2 OU-2

The following subsections summarize the objectives, status, and performance to date of the OU-2 groundwater treatment system.

4.1.2.1 OU-2 Final ROD/CB-Part 1 ROD

The stated objective of the OU-2 groundwater treatment system in the OU-2 Final ROD was to remediate degraded groundwater in the OU-2 area that is not laterally covered by the OU-1 groundwater treatment system. The OU-2 area is defined as the areas of the DA-4 and Wallace Road removal actions and contiguous areas off base where contaminated groundwater has migrated (See Figure 2-2). The major components of the selected remedy were:

- Design, construction, and operation of a groundwater extraction and treatment system to treat extracted groundwater with a packed tower air stripping method and carbon treatment of air stripper off-gases to levels that meet applicable effluent limits.
- Discharge of treated groundwater by injection, primarily to the same HSZs from which it was extracted (Shallow and USS HSZs); one injection well (IW04) is completed in the LSS HSZ.
- Groundwater monitoring to demonstrate that the extraction system is effectively capturing the VOC contaminant plume, attainment of the cleanup standards established for OU-2 (MCLs), and compliance with all ARARs.

All of the listed components of the OU-2 Final ROD are compatible with the objectives of the CB-Part 1 ROD, which has superseded the OU-2 Final ROD. Prior to construction, the system design was changed to use GAC for groundwater treatment rather than packed tower air strippers. An ESD regarding the change from air stripping to GAC was submitted on 7 December 1994 (USAF, 1994). This ESD was approved by all parties (final signature) on

13 December 1994. Standards for treated groundwater, which were originally MCLs in the OU-2 Final ROD, were revised to match those listed in the CB-Part 1 ROD prior to the system coming on line (for TCE, 30-day median of 0.5 μg/L).

4.1.2.2 OU-2 Operational History and Performance Assessment

The OU-2 groundwater treatment system was placed in operation on 26 November 1996 and, through June 1998, has been in operation for approximately one year, seven months. The OU-2 system location and design were described in Section 2.3.2.2. The operational history of the OU-2 system has been relatively short and uneventful. Except for the date when the system was placed in operation, the only other event that warrants mention is the failure of the internal structure of one of the OU-2 four carbon vessels. This failure occurred during a carbon changeout in November 1997. Because this carbon vessel represented excess capacity, the failure did not affect the OU-2 system treatment capacity and there was no risk to human health or the environment associated with the failure.

An operational summary of the OU-2 groundwater treatment system is provided in Table 4-3, which lists monthly values related to system operation equivalent to those provided for OU-1. Through June of 1998, the plant has treated a total of approximately 998.5 million gallons of groundwater and has removed approximately 302 pounds of TCE from the Main Base Plume (Shallow and USS HSZs). The influent TCE concentration has declined from an average of approximately 50 μg/L during the first six months of operation to an average of approximately 28.5 μg/L during the last six months of operation. Correspondingly, the mass of TCE removed has increased from an average of approximately 14 pounds per month to an average of approximately 15 pounds per month. This increase is because the average amount of water treated monthly by the plant was much less during the first six months of operation (31.4 million gallons) than during the last six months (64 million gallons). The amount of groundwater pumped was less during the early months of operation due to minor equipment problems and system adjustments following startup. There have been measurable and continuing reductions in the capacity of several of the OU-2 injection wells but, with intermittent redevelopment, this has not affected treatment plant capacity to date. Cumulative TCE removed and water treated and monthly values for

TCE removed and water treated by the OU-2 groundwater treatment system are shown on Figure 4-3.

Hydraulic (water level) effects in the Shallow and USS HSZs resulting from OU-2 groundwater treatment system operation can be seen by comparing the groundwater elevation contours shown on Figures 3-2 and 3-4 (Q4/96—just prior to system startup) with those shown on Figures 3-3 and 3-5 (Q2/98). The changes in the areas of greatest influence of the OU-2 system (grid locations K5-8, L5-8, M5-8, N5-8, P5-8, Q5-8, and R5-8) are obvious in both the Shallow and USS HSZs. Localized mounds and depressions have been created in the potentiometric surfaces of both HSZs and there has been a noticeable reduction in the westward hydraulic gradient in both HSZs. This reduction in westward gradient significantly reduces the potential for further plume migration in the off-base areas to the west of Castle Airport.

The effects of OU-2 system operation on the Main Base Plume in the Shallow and USS HSZs can be seen by comparing TCE concentration contours shown on Figures 3-11 and 3-13 (Q4/96) with those shown on Figures 3-12 and 3-14 (Q2/98). Only relatively minor changes in plume configuration have occurred in either HSZ. The plume has not migrated further westward in either HSZ. Figures 4-2 and 4-4 show the estimated extent of hydraulic capture in the Shallow and USS HSZs as of Q2/98. These figures show that the OU-2 system (grid locations as above) is providing hydraulic control and is effectively capturing contaminated groundwater within the 5 μg/L contour (MCL for TCE) of the Main Base Plume in both the Shallow and USS HSZs. Groundwater modeling results and subsequent monitoring results (Q3/98), (not presented in this report but presented in the draft TEER [Jacobs, 1998b]), indicate that full hydraulic control may be lacking, at least seasonally, in the USS HSZ.

4.1.2.3 OU-2 ARARs Review

ARARs associated with OU-2 groundwater treatment system operation are listed in Section 4 of the CB-Part 1 ROD. Changes to these ARARs have not been requested or proposed and an ARARs review is not a standard component of a Type Ia five-year review

(EPA, 1994). No changes to the OU-2 groundwater treatment system were required by changes in ARARs.

4.1.2.4 OU-2 Summary of Site Visits

The OU-2 groundwater treatment system is an ongoing remedial action. The treatment plant, extraction and injection wells, and the conveyance system (pipelines) are observed daily by contractor personnel responsible for O&M. AFBCA personnel with offices at Castle Airport regularly observe the system. Regulatory agency personnel typically visit Castle Airport monthly.

4.1.2.5 OU-2 Areas of Noncompliance

Operation of the OU-2 groundwater treatment system has, in general, been in compliance with requirements of the CB-Part 1 ROD. There have been no specific noncompliance events. The combined existing remedial system for the Main Base Plume is likely not in full compliance with the CB-Part 1 ROD in that full hydraulic control of the plume in the USS, LSS, and Confined HSZs may not be achieved during all seasons of the year.

The combined existing remedial system for the Main Base Plume has also not met the CB-Part 1 ROD objective, which stipulates cleanup of the groundwater to the MCL (TCE). This objective cannot be met for some time.

4.1.3 Phase 2

The following subsections summarize the objectives, status, and performance to date of the Phase 2 groundwater treatment system.

4.1.3.1 CB-Part 1 ROD

In addition to the overall objectives of plume capture and cleanup to MCL levels, the stated objectives of the Phase 2 groundwater treatment system in the CB-Part 1 ROD were to eliminate the addition of TCE mass to the Main Base Plume in the Confined HSZ; remediate "hot spots" of TCE contamination in the USS, LSS, and Confined HSZs; and remediate a residual hot spot in the Shallow HSZ. Groundwater cleanup and treated groundwater discharge standards for the Phase 2 system are those established in the CB-Part 1 ROD for TCE: 5 μg/L and a 30-day median of 0.5 μg/L, respectively.

4.1.3.2 Phase 2 Operational History and Performance Assessment

The Phase 2 groundwater treatment system was placed in operation on 29 September 1997 and, through June 1998, has been in operation for approximately nine months. The location and design of the Phase 2 system was described in Section 2.3.2.3. The only significant milestones or events that warrant listing are the date when the system was placed in operation and a minor spill of untreated groundwater that occurred at the treatment plant on 27 December 1997.

An operational summary of the Phase 2 groundwater treatment system is provided in Table 4-4. Through June 1998, the Phase 2 system has treated approximately 271.9 million gallons of groundwater and removed approximately 73 pounds of TCE. Influent TCE concentration has averaged about 33 μg/L, while the average flow rate through the treatment plant has been approximately 785 gpm. Cumulative TCE removed and water treated and monthly values for TCE removed and water treated by the Phase 2 groundwater treatment system are shown on Figure 4-5.

The treatment plant flow rate has been limited by measurable and continuing reductions in the capacity of several of the systems injection wells. A well redevelopment program is ongoing to maintain the treatment plant flow rate. As noted in Section 2.3.2.3, two surface water discharge options are available for treated water from the Phase 2 plant. Since early May 1998, a portion of the treated water from the Phase 2 plant (approximately 400-450 gpm) has been discharged to the Casad Lateral via the intertie to the OU-2 discharge pipeline. This discharge, which also helps maintain treatment plant capacity, is in compliance with the current NPDES permit and the provisions of the CB-Part 1 ROD.

Hydraulic (water level) effects in the Shallow HSZ resulting from operation of the Phase 2 groundwater treatment system are minimal because none of the injection wells and only one Phase 2 extraction well (EW18) are completed in the Shallow HSZ. Hydraulic effects in the

USS, LSS, and Confined HSZs resulting from Phase 2 groundwater treatment operation can be seen by comparing the groundwater elevation contours shown on Figures 3-4, 3-6, and 3-8 (Q4/96 and Q4/97 – prior to system startup) with those shown on Figures 3-5, 3-7, and 3-9 (Q2/98). The changes in the areas of greatest influence of the Phase 2 system (grid locations M7-9, N7-9, R8-11, S8-11, T12-13, and U12-13) are obvious in each of the deeper HSZs. Localized mounds and depressions have been created in the potentiometric surfaces of each of the HSZs and there have been noticeable changes in the general westward flow direction that previously characterized these HSZs. These changes in flow direction and hydraulic gradient significantly reduce the potential for further plume migration to the west of Castle Airport.

The effects of Phase 2 system operation on the Main Base Plume in the USS, LSS, and Confined HSZs can be assessed by comparing TCE concentration contours shown on Figures 3-13, 3-15, and 3-17 (Q4/96 and Q4/97) with those shown on Figures 3-14, 3-16, and 3-18 (Q2/98). Only relatively minor changes in plume configuration have occurred in any of the HSZs but again, there is no indication of further westward migration of the plume. Figures 4-4, 4-6, and 4-7 show the estimated extent of hydraulic capture in the USS, LSS, and Confined HSZs as of Q2/98. These figures suggest that the Phase 2 system (grid locations as noted previously) is providing hydraulic control of the Main Base Plume in the USS and LSS HSZs but may not be providing full hydraulic control in the Confined HSZ. Groundwater modeling results and subsequent monitoring results (Q3/98), not presented in this report but presented in the draft TEER (Jacobs, 1998b), indicate that full hydraulic control may also be lacking, at least seasonally, in the USS and LSS HSZs.

4.1.3.3 Phase 2 ARARs Review

ARARs associated with Phase 2 groundwater treatment system operation are listed in Section 4 of the CB-Part 1 ROD. Changes to these ARARs have not been requested or proposed and an ARARs review is not a standard component of a Type Ia five-year review (EPA, 1994). No changes to the Phase 2 groundwater treatment system have been required by changes in ARARs.

4.1.3.4 Phase 2 Summary of Site Visits

The Phase 2 groundwater treatment system is an ongoing remedial action. The treatment plant, extraction and injection wells, and the conveyance system (pipelines) are observed daily by contractor personnel responsible for O&M. AFBCA personnel with offices at Castle Airport regularly observe the system. Regulatory agency personnel typically visit Castle Airport monthly.

4.1.3.5 Phase 2 Areas of Noncompliance

Operation of the Phase 2 groundwater treatment system has, in general, been in compliance with requirements of the CB-Part 1 ROD. The only known noncompliance event occurred on 27 December 1997. On this date, a spill of untreated groundwater occurred at the Phase 2 treatment plant after an interlock to one of the extraction wells (EW23) had accidentally been left disabled during maintenance/system upgrade activities. The spill rate and duration was approximately 60 gpm for four hours (14,400 gallons). The water eventually entered the Castle Airport stormwater canal. A Problem Analysis Report addressing the incident was prepared and submitted to the Air Force on 26 January 1998. A number of corrective actions were identified: (1) adding a control screen indicator alerting the operator if an alarm function is disabled; (2) requiring programmers to complete a system exit checklist to ensure that all alarms are still functioning after any plant programming changes are made; (3) requiring the plant operator to check the status off all system parameters, including extraction wells, when the plant shuts down; and (4) quarterly testing of the treatment system's ability to shut down due to a high-high water level in the influent tank.

The combined existing remedial system for the Main Base Plume is likely not in full compliance with the CB-Part 1 ROD in that full hydraulic control of the plume in the USS, LSS, and Confined HSZs may not be achieved during all seasons of the year.

The combined existing remedial system for the Main Base Plume has also not met the CB-Part 1 ROD objective which stipulates cleanup of the groundwater to the MCL (TCE). This objective cannot be met until some time in the future.

4.1.4 Castle Vista

The following subsections summarize the objectives, status, and performance to date of the Castle Vista groundwater treatment system.

4.1.4.1 CB-Part 1 ROD

The CB-Part 1 ROD identified groundwater pump-and-treat as a presumptive remedy to remediate the *cis*-1,2-DCE plume that exists in the Shallow and USS HSZs to the west and southwest of CVLF-B. The system was designed in view of the overall objective of the CB-Part 1 ROD, which is to capture contaminated groundwater within the MCL boundary of the most restrictive contaminant present (in this case *cis*-1,2-DCE) and clean up the groundwater to MCL levels (6 µg/L for *cis*-1,2-DCE). A focused feasibility study was conducted and the results reported in the final (pending) *Castle Vista Landfill B Groundwater Remedial Action Work Plan Addendum* (Jacobs, 1998f). This analysis verified that MCLs are the appropriate cleanup levels for the Castle Vista Plume and that such cleanup levels are consistent with Section IIIG of SWRCB Resolution No. 92-49 (SWRCB, 1994) (Jacobs, 1998f). Treated groundwater discharge standards for the Castle Vista system are those established in the CB–Part 1 ROD, for *cis*-1,2-DCE, a 30-day median of 0.5 µg/L.

4.1.4.2 Castle Vista Operational History and Performance Assessment

The Castle Vista groundwater treatment system was placed in operation on 27 October 1997 and, through June 1998, has been in operation for approximately eight months. The location and design of the Castle Vista system are described in Section 2.3.2.4. Except for the date that the system was placed in operation, there have been no significant milestones or events that warrant listing.

An operational summary of the Castle Vista groundwater treatment system is provided in Table 4-5. Through June 1998, the Castle Vista system has treated approximately 156.1 million gallons of groundwater and has removed approximately 14 pounds of *cis*-1,2-DCE. The influent *cis*-1,2-DCE concentration has averaged about 12 µg/L, while the average flow rate through the treatment plant has been approximately 495 gpm. Cumulative *cis*-1,2-DCE removed and water treated and monthly values for *cis*-1,2-DCE removed and water treated by the Castle Vista groundwater treatment system are shown on Figure 4-8.

Hydraulic (water level) effects in the Shallow and USS HSZs resulting from Castle Vista groundwater treatment system operation can be seen by comparing groundwater elevation contours shown on Figures 3-2 and 3-4 (Q4/96 – prior to system startup) with those shown on Figures 3-3 and 3-5 (Q2/98). The changes in the areas of greatest influence of the Castle Vista system (grid locations T4, U2-4, and V4) are obvious in the Shallow HSZ and subtle in the USS HSZ. Localized mounds and depressions have been created in the potentiometric surface for the Shallow HSZ (the water table) and groundwater flow direction has been locally modified to reflect flow toward the Shallow HSZ extraction wells. The only noticeable change in the USS HSZ is a localized depression in the potentiometric surface around USS HSZ extraction well EW30.

The effects of Castle Vista system operation on the Castle Vista Plume in the Shallow and USS HSZs can be assessed by comparing TCE concentration contours shown on Figures 3-19 and 3-21 (Q4/97) with those shown on Figures 3-20 and 3-22 (Q2/98). While noticeable changes have occurred in the distribution of the 50 μg/L *cis*-1,2-DCE contour in the Shallow HSZ, for the most part only relatively minor changes in plume configuration have occurred in the Shallow and USS HSZs. Figures 4-9 and 4-10 show the estimated extent of hydraulic capture in the Shallow and USS HSZs as of Q2/98. These figures, adapted from the draft TEER (Jacobs, 1998b), show the *cis*-1,2-DCE plume and a 0.5 μg/L plume boundary for PCE (the MCL for PCE is 5 μg/L). These figures indicate that the existing Castle Vista system is providing almost full hydraulic control of the plumes in the Shallow HSZ, but is providing only partial hydraulic control of the plumes in the USS HSZ. The Air Force has proposed the installation of wellhead treatment on City of Atwater municipal water supply well AM6 and the use of AM6 as an extraction well to aid remediation of the Castle Vista Plume (Jacobs, 1998f). Modeling results presented in the draft TEER (Jacobs, 1998b), but not included in this report, show that complete capture of the plumes in the USS HSZ is achieved with operation of EW30 and AM6 as extraction wells.

4.1.4.3 Castle Vista ARARs Review

ARARs associated with Castle Vista groundwater treatment system operation are listed in Section 4 of the CB-Part 1 ROD. Changes to these ARARs have not been requested or proposed and an ARARs review is not a standard component of a Type Ia five-year review (USEPA, 1994). No changes to the Castle Vista groundwater treatment system have been required by changes in ARARs.

4.1.4.4 Castle Vista Summary of Site Visits

The Castle Vista groundwater treatment system is an ongoing remedial action. The treatment plant, extraction and injection wells, and the conveyance system (pipelines) are observed daily by contractor personnel responsible for O&M. AFBCA personnel with offices at Castle Airport regularly observe the system. Regulatory agency personnel typically visit Castle Airport monthly.

4.1.4.5 Castle Vista Areas of Noncompliance

Operation of the Castle Vista groundwater treatment system has been in compliance with requirements of the CB-Part 1 ROD with the exception that the existing system does not provide full hydraulic control of the *cis*-1,2-DCE and PCE plumes in the USS HSZ. As mentioned previously, to provide full hydraulic control of the plumes in the USS HSZ, the Air Force has proposed installation of wellhead treatment at City of Atwater municipal water supply well AM6 and operation of the well as an extraction well for the Castle Vista groundwater treatment system. In addition, two to three new monitoring wells are planned in the vicinity of AM6. The purpose of these wells will be to better monitor the effectiveness of plume remediation in the USS HSZ. The plans and schedule for implementation of wellhead treatment at AM6 are currently being negotiated.

A small portion of the *cis*-1,2-DCE and PCE plumes in the Shallow HSZ (northwest) may also not be under full hydraulic control at present. This is viewed as an insignificant factor in that the area of the plumes not controlled is very small, the contaminant concentrations are very low, and modeling results (draft TEER; Jacobs, 1998b) indicate that continued operation of the existing system will provide full hydraulic control and remediation of this area in the near future.

The Castle Vista groundwater system has also not met the CB-Part 1 ROD objective which stipulates cleanup of the groundwater to the MCL (*cis*-1,2-DCE). This objective cannot be met until some time in the future.

4.1.5 Phase 3

The purpose of the Phase 3 remedial action at Castle Airport is to ensure that the remedial system for the Main Base Plume can meet all remedial objectives defined in the CB-Part 1 ROD. A comprehensive effectiveness evaluation of the existing remedial system (OU-1, OU-2, and Phase 2) has been performed. The results of this evaluation and initial recommendations for Phase 3 remedial action are provided in the draft TEER (Jacobs, 1998b), which was submitted for regulatory agency review on 9 October 1998. The recommended Phase 3 action addresses the areas of noncompliance identified in this report, i.e., apparent or potential (seasonal) lack of full hydraulic control of the Main Base Plume in the USS, LSS, and Confined HSZs. In addition, the recommended Phase 3 action also seeks to improve mass removal rates and to reduce the projected schedule for remediation. Initial recommendations for Phase 3 consist of eight additional extraction wells (five in the USS HSZ, two in the LSS HSZ, one in the Confined HSZ); 12 additional injection wells (two in the Shallow HSZ, seven in the USS HSZ, three in the LSS HSZ); two additional monitoring wells in the LSS HSZ; and expansion of the existing Phase 2 plant and conveyance system to treat an additional 815 gpm of contaminated groundwater. Final recommendations for Phase 3 may differ from the above due to the review process and the fact that additional monitoring data will continue to be collected and effectiveness evaluations updated.

4.2 SCOU ROD

The SCOU ROD has been issued as a draft (Waste Policy Institute, 1997), but is not final as of the date of this five-year review. The remedial objectives established in the Final SCOU ROD or RODs will be summarized in future five-year reviews.

4.2.1 SCOU Sites Operational History and Performance Assessment

Remedial actions have not been implemented at any SCOU sites because the SCOU ROD is not final. Removal actions have been initiated by the Air Force at several SCOU sites where existing contaminant concentrations may have posed a significant risk to human health or the environment. A brief description of these removal actions, and their status, is presented in Sections 2.4.1 through 2.4.13.

4.2.2 SCOU ARARs Review

ARARs review is not applicable for this five-year review since the SCOU ROD is not final and ARARs have not been identified.

4.2.3 SCOU Sites Summary of Site Visits

Remedial actions have not been initiated to date at any SCOU sites since the SCOU ROD is not final. The ongoing removal actions at selected SCOU sites are observed daily by contractor personnel responsible for O&M. AFBCA personnel with offices at Castle Airport regularly observe these removal actions and any operating systems, such as the SVE system at FTA-1. Regulatory agency personnel typically visit Castle Airport monthly.

4.2.4 SCOU Sites Areas of Noncompliance

Not applicable for this five-year review since the SCOU ROD is not final and no remedial actions have been initiated.

4.3 CB–PART 2 ROD

The CB-Part 2 ROD will address any necessary remedial actions for groundwater or the vadose zone that are not addressed in the CB-Part 1 ROD or the SCOU ROD. The CB-Part 2 ROD will not be prepared until the SCOU ROD or RODs are finalized. Present scheduling indicate that the second SCOU ROD will not be finalized until on or about 21 September 2000. The CB-Part 2 ROD will be addressed in future five-year reviews.

Table 4-1
Treated Groundwater Discharge Standards

Constituent	Standards for Discharge[1]	
	30-Day Median (µg/L)	Daily Maximum (µg/L)
Acetone	1	-
Benzene	0.5	1
Bromoform	0.5	1
Carbon tetrachloride	0.5	0.5
Chloroethane	0.5	1
Chloroform	0.5	1
Chloromethane	0.5	1
chlorobenzene	0.5	1
Dibromochloropropane (DBCP)	0.35	5
Di(2-ethylhexyl)phthalate (DEHP)	0.5	1
Dichlorobenzene (ortho)	0.5	1
Dichlorobenzene (para)	0.5	1
Dichlorodifluoromethane	0.5	1
1,1-DCE	0.5	1
1,2-DCE (*cis*)	0.5	1
1,2-DCE (*trans*)	0.5	1
1,1-DCA	0.5	1
1,2-DCA	0.5	0.5
1,2-dichloropropane	0.5	1
Ethylbenzene	0.5	29
Ethylene dibromide	0.14	0.5
Methylene chloride	0.5	1
Tetrachloroethene (PCE)	0.5	1
Toluene	0.5	42
Trichlorofluoromethane	0.54	1
Trichloroethene (TCE)	0.5	1
VOCs	1	5
Xylenes	0.5	17
TPH (gas)	50	50
TPH (diesel)	50	100
Iron	-	300[2]
Manganese	-	50[2]
Nitrates	-	10 mg/L as Nitrogen[2]
Other constituents	All other constituents must be within background concentrations in the receiving water at the point of discharge. If this is not technically feasible, discharge standards may be established.	

Notes
[1]For discharge into the contaminated regions of an aquifer, in lieu of the standards in this table, treated water cannot be discharged at concentrations that exceed the specified aquifer clean-up level or the actual concentrations in the aquifer at the point of discharge, whichever is lower. For constituents where no aquifer clean-up level has been specified, treated water cannot be discharged at constituent concentrations that exceed those of the receiving water.
[2]or 95% UTL background at point of discharge, if higher.

General Note: All COCs will be included in routine long-term groundwater monitoring; other constituents will be sampled according to the approved LTGSP sampling plan.

Source: AFCEE, 1997. Final Record of Decision for Comprehensive Basewide–Part 1, Castle Air Force Base, Merced County, California, as modified by memorandum of non-significant changes to record of decision, 9 December 1997.

µg/L	Micrograms per liter
COC	Contaminant of concern
mg/L	Milligrams per liter
TPH	Total petroleum hydrocarbons
UTL	Upper threshold limit
VOC	Volatile organic compound

Table 4-2
Summary of Operation, OU-1 Groundwater Treatment System

Time Period	Average Water Flow Rate Through Plant (gpm)	Total Water Treated (1,000 gallons)	Treatment Plant Downtime (hours/percent)	Influent TCE Concentration (µg/L)	Mass of TCE Removed (lbs.)	Mass of TCE Released to Atmosphere (lbs./day)
7/29/94-10/31/94	250	34,200	<85/<4.0	120 (est.)	31.7	0.36
11/1/94-1/31/95	205	39,060	<85/<4.0	110 (est.)	35.8	0.39
2/95	297	10,400	NA	89	7.7	0.28
3/95	241	10,745	NA	94	8.4	0.27
4/95	295	12,743	NA	86	9.1	0.3
5/95	280	12,469	NA	100	10.4	0.34
6/95	128	5,624	NA	100	4.7	0.16
7/95	106	4,560	NA	130	4.9	0.16
8/95	235	10,600	NA	73	6.5	0.21
9/95	289	11,000	NA	85	8.3	0.28
10/95	271	11,100	NA	130	13.8	0.45
11/95	328	11,200	NA	120	13.3	0.44
12/95	273	10,700	NA	98	9.1	0.29
1/96	206	10,227	41/5.5	80	7	0.23
2/96	215	8,901	6/0.9	74	5.5	0.2
3/96	235	10,438	9/1.2	89	7.8	0.25
4/96	300	12,099	48/6.5	80	8.1	0.27
5/96	208	9,082	18.5/2.5	93	7	0.23
6/96	197	8,528	40/5.6	81	5.8	0.19
7/96	185	8,280	104/14.0	110	7.6	0.25
8/96	372	11,703	228/30.1	94	9.2	0.3
9/96	225	9,729	203/28.2	111	9	0.3
10/96	403	16,919	46/6.2	120	16.9	0.56
11/96	386	16,674	11.5/1.6	120	16.7	0.56
12/96	367	16,331	18.6/2.5	120	16.4	0.55
1/97	360	16,055	5/0.7	75	10	0.33
2/97	398	16,055	7/1.0	84	11.3	0.38
3/97	399	14,306	10.5/1.4	93	11.1	0.37
4/97	399	16,874	0/0.0	85	12	0.4
5/97	413	18,233	7/0.9	86	13.1	0.44
6/97	407	16,639	38.5/5.3	83	12.6	0.42
7/97	415	16,931	61/8.2	83	11.7	0.38
8/97	422	18,692	1.5/0.2	73	11.4	0.37
9/97	425	14,979	133/18.5	65	8.1	0.27

Table 4-2
Summary of Operation, OU-1 Groundwater Treatment System

Time Period	Average Water Flow Rate Through Plant (gpm)	Total Water Treated (1,000 gallons)	Treatment Plant Downtime (hours/percent)	Influent TCE Concentration (µg/L)	Mass of TCE Removed (lbs.)	Mass of TCE Released to Atmosphere (lbs./day)
10/97	422	18,161	40.5/5.4	57	8.6	0.27
11/97	421	17,954	9.0/1.2	51	7.6	0.25
12/98	410	17,850	3.5/0.5	53	7.9	0.25
1/98	409	16,627	70.5/9.5	56	7.8	0.25
2/98	397	13,937	86.5/12.9	52	6	0.22
3/98	378	15,633	52/7.0	46	6	0.19
4/98	362	14,124	30/4.2	47	5.5	0.18
5/98	370	16,251	11.8/1.6	48	6.5	0.21
6/98	375	14,843	53.8/7.5	46	5.7	0.19
Totals		**617,456**			**443.6**	

Notes

µg/L	Micrograms per liter
gpm	Gallons per minute
lbs	Pounds
NA	Not available
TCE	Trichloroethene

Table 4-3
Summary of Operation, OU-2 Groundwater Treatment System

Time Period	Average Water Flow Rate Through Plant (gpm)	Total Water Treated (1,000 gallons)	Treatment Plant Downtime (hours/percent)	Influent TCE Concentration (µg/L)	Mass of TCE Removed (lbs)
12/96	?	?	?	36	?
1/97	752	33,552	72 / 9.7	65.4	18.3
2/97	519	20,937	251 / 37.4	47.3	8.3
3/97	1,425	32,766	294 / 39.5	57.6	15.8
4/97	1,329	40,530	208 / 28.9	32.3	10.9
5/97	1,626	60,582	117 / 15.7	63	30.7
6/97	1,668	62,228	23 / 3.2	47	24.6
7/97	1,447	60,800	1 / 0.1	39.7	20.4
8/97	1,678	57,951	118 / 15.9	30.5	14.9
9/97	1,765	67,152	46 / 6.4	36	20.2
10/97	1,585	60,459	105 / 14.1	30.4	15.4
11/97	1,811	39,831	4.5 / 0.6	31.6	10.5
12/98	1,789	77,859	16 / 2.2	32.4	21
1/98	1,692	54,808	199 / 26.7	30.1	13.8
2/98	1,722	58,380	107 / 15.9	32	15.6
3/98	1,719	72,356	30/4.0	32.1	19.4
4/98	1,696	65,825	65/8.7	25	13.7
5/98	1,683	75,144	0/0.0	26.9	16.9
6/98	1,327	57,328	72.3/9.7	25	12
Totals		**998,488**			**302.4**

Notes

?	Plant data recording features not operational from startup (26 November 1996) through December 1996.
µg/L	Micrograms per liter
gpm	Gallons per minute
lbs	Pounds
TCE	Trichloroethene

Table 4-4
Summary of Operation, Phase 2 Groundwater Treatment System

Time Period	Average Water Flow Rate Through Plant (gpm)	Total Water Treated (1,000 gallons)	Treatment Plant Downtime (hours/percent)	Influent TCE Concentration (µg/L)	Mass of TCE Removed (lbs)
9/97	?	?	?	?	?
10/97	530	13,514	338.3/45.5	38	4.3
11/97	843	34,742	21/2.9	26.9	7.5
12/97	837	34,306	11.5/1.5	34.8	10
1/98	809	32,723	45/6.0	35.8	9.8
2/98	742	27,155	59.5/8.9	34	7.7
3/98	632	25,249	77/10.3	35.6	7.5
4/98	743	26,118	133/18.5	31.1	6.8
5/98	896	38,288	25/3.4	29.5	9.4
6/98	1,014	39,789	65.7/9.1	29.1	9.7
Totals		**271,884**			**72.7**

Notes

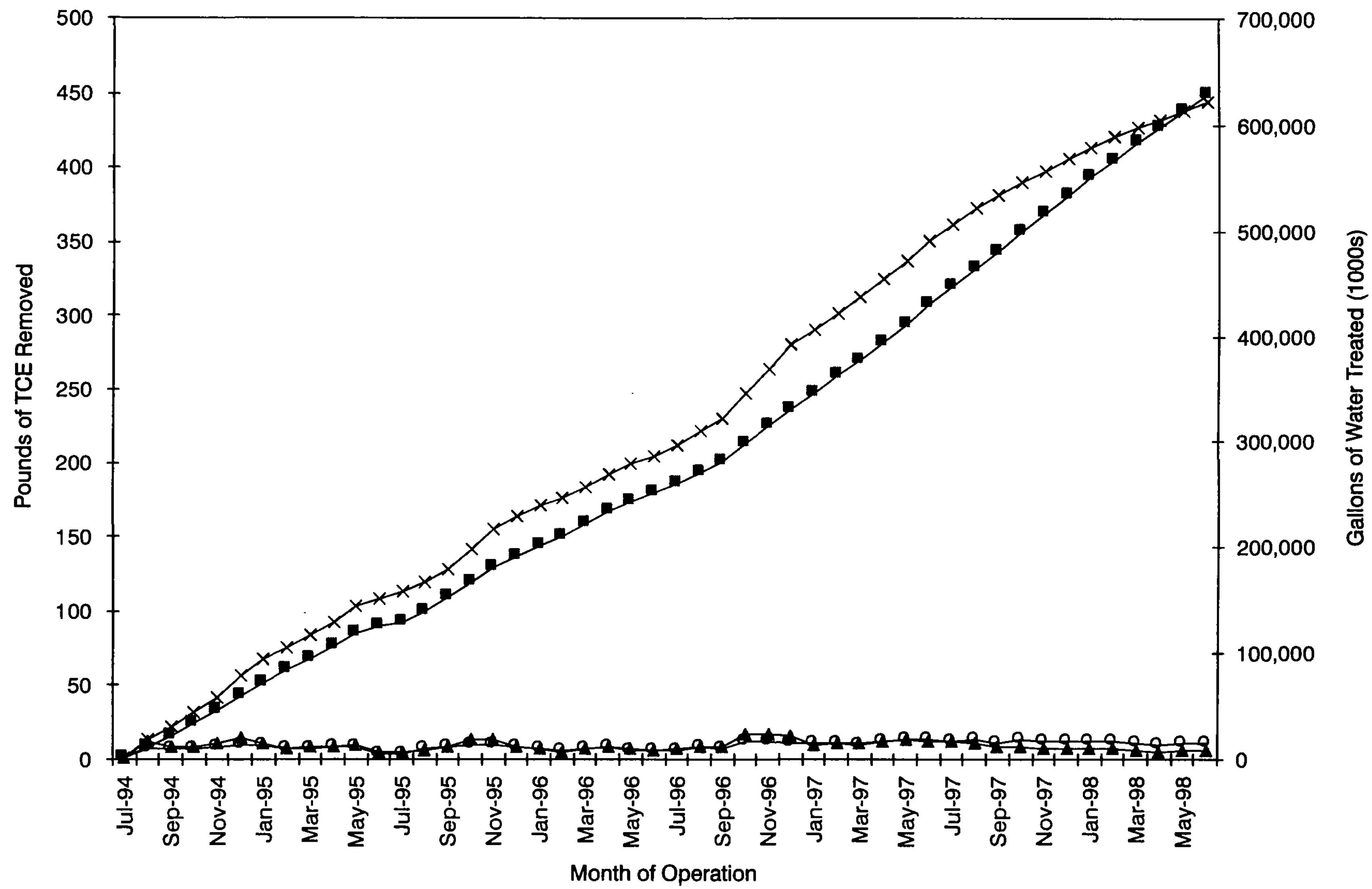
?	Time from startup (22 September 1997) through end of September 1997 spent on various plant startup and flow balancing activities
µg/L	Micrograms per liter
gpm	Gallons per minute
lbs	Pounds
TCE	Trichloroethene

Table 4-5
Summary of Operation, Castle Vista Groundwater Treatment System

Time Period	Average Water Flow Rate Through Plant (gpm)	Total Water Treated (1,000 gallons)	Treatment Plant Downtime (hours/percent)	Influent *cis*-1,2-DCE Concentration (µg/L)	Mass of *cis*-1,2-DCE Removed (lbs)
11/97	456	18,751	10/1.4	21.5	2.8
12/97	446	19,714	7.5/1.0	12.5	1.7
1/98	491	20,481	26/3.5	14.2	2.4
2/98	522	12,993	249/37.1	13	1.4
3/98	502	19,982	76/10.2	10.8	1.8
4/98	509	20,580	46/6.4	8.3	1.4
5/98	518	22,569	1/0.1	6.5	1.2
6/98	511	20,998	30/4.2	8.1	1.4
Totals		**156,068**			**14.1**

Notes

µg/L Micrograms per liter
cis-1,2-DCE *cis*-1,2-Dichloroethene
gpm Gallons per minute
lbs Pounds



LEGEND

- TCE Removed Per Month (pounds)
- Cumulative TCE Removed (pounds)
- Treated Water per Month (1000s Gallons)
- Cumulative Treated Water (1000s Gallons)

Cummulative and Monthly Groundwater Treated and TCE Removed - OU-1

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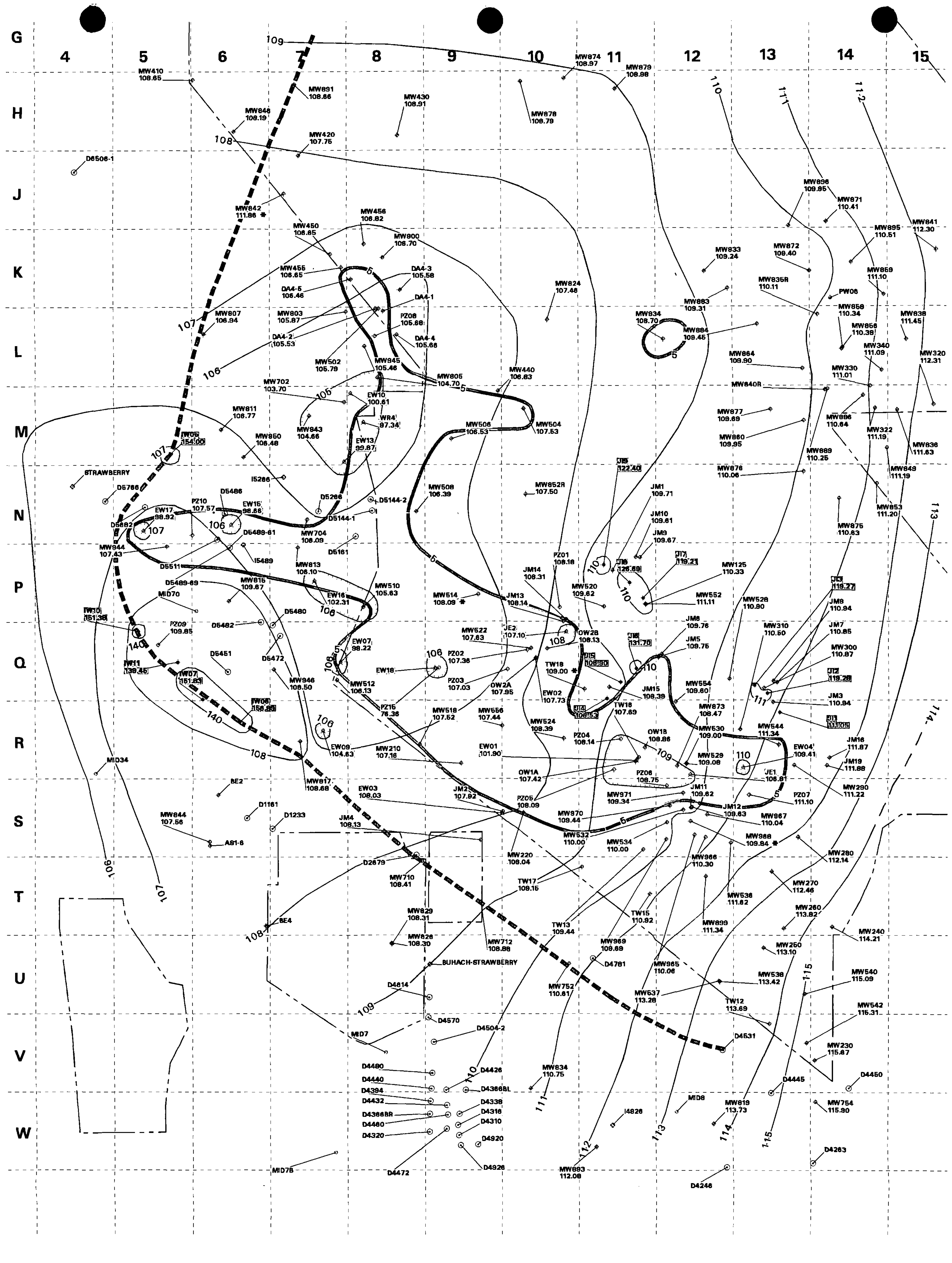
Castle Airport

11/2/98 gmh file:..cadd\27k72501\97_semi\4-1.cdr *Job No. 27-K725-01*

FIGURE 4-1



LEGEND

- MW001 Monitoring well
- D4740 Domestic well
- I1-01 Irrigation well-private
- MID1 Irrigation well-public
- EW01 Extraction well
- JI6 Injection well
- IW01 Injection well-off line
- PZ03 Piezometer
- PW15 Production well
- AM11 Municipal well
- Area of groundwater elevation drawdown
- Property boundary
- Groundwater elevation contours in feet above mean sea level; dashed where inferred
- MW875 60.11 Well location with groundwater elevation data
- 5 μg/L TCE isoconcentration contour (Q2/98)
- Estimated zone of capture

* Data not used in contouring

Note: Dry wells not shown on map

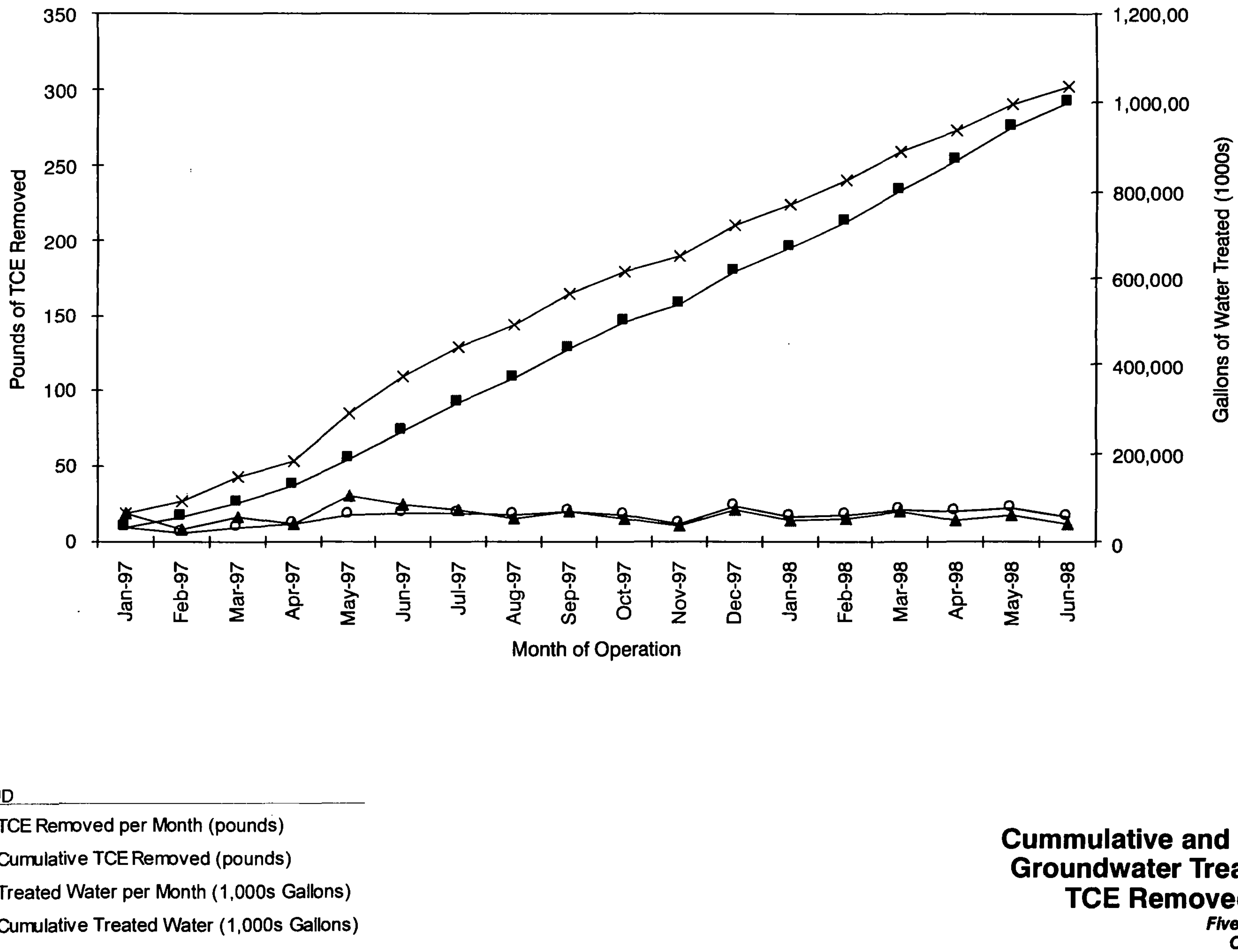
N

0 1200

Scale in Feet
1:14400

Estimated Plume Capture
for the Shallow Hydrostratigraphic Zone
Main Base Plume Remedial System, Second Quarter 1998

Five-Year Review
Castle Airport

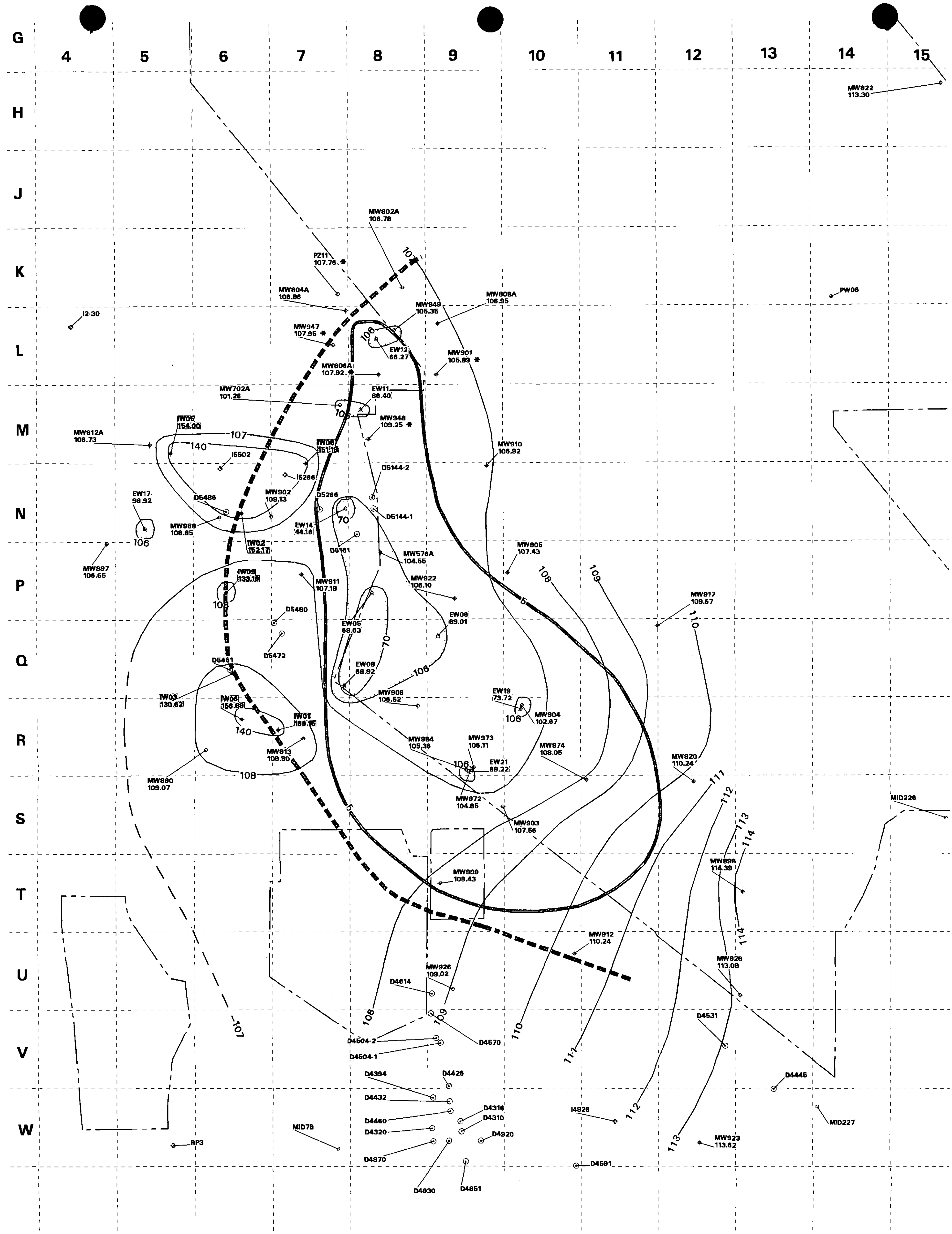


Cummulative and Monthly Groundwater Treated and TCE Removed - OU-2

Five-Year Review
Castle Airport

11/2/98 gmh file:..cadd\27k72501\97_semi\4-3.cdr *Job No. 27-K725-01*

FIGURE 4-3



LEGEND

- MW001 Monitoring well
- D4740 Domestic well
- I1-01 Irrigation well-private
- MID1 Irrigation well-public
- EW01 Extraction well
- JI6 Injection well
- PW15 Production well
- PZ03 Piezometer
- AM11 Municipal well
- Area of groundwater elevation drawdown
- Property boundary
- Groundwater elevation contours in feet above mean sea level; dashed where inferred
- MW875 60 11 Well location with groundwater elevation data
- 5 μg/L TCE isoconcentration contour (Q2/98)
- Estimated zone of capture

* Data not used in contouring

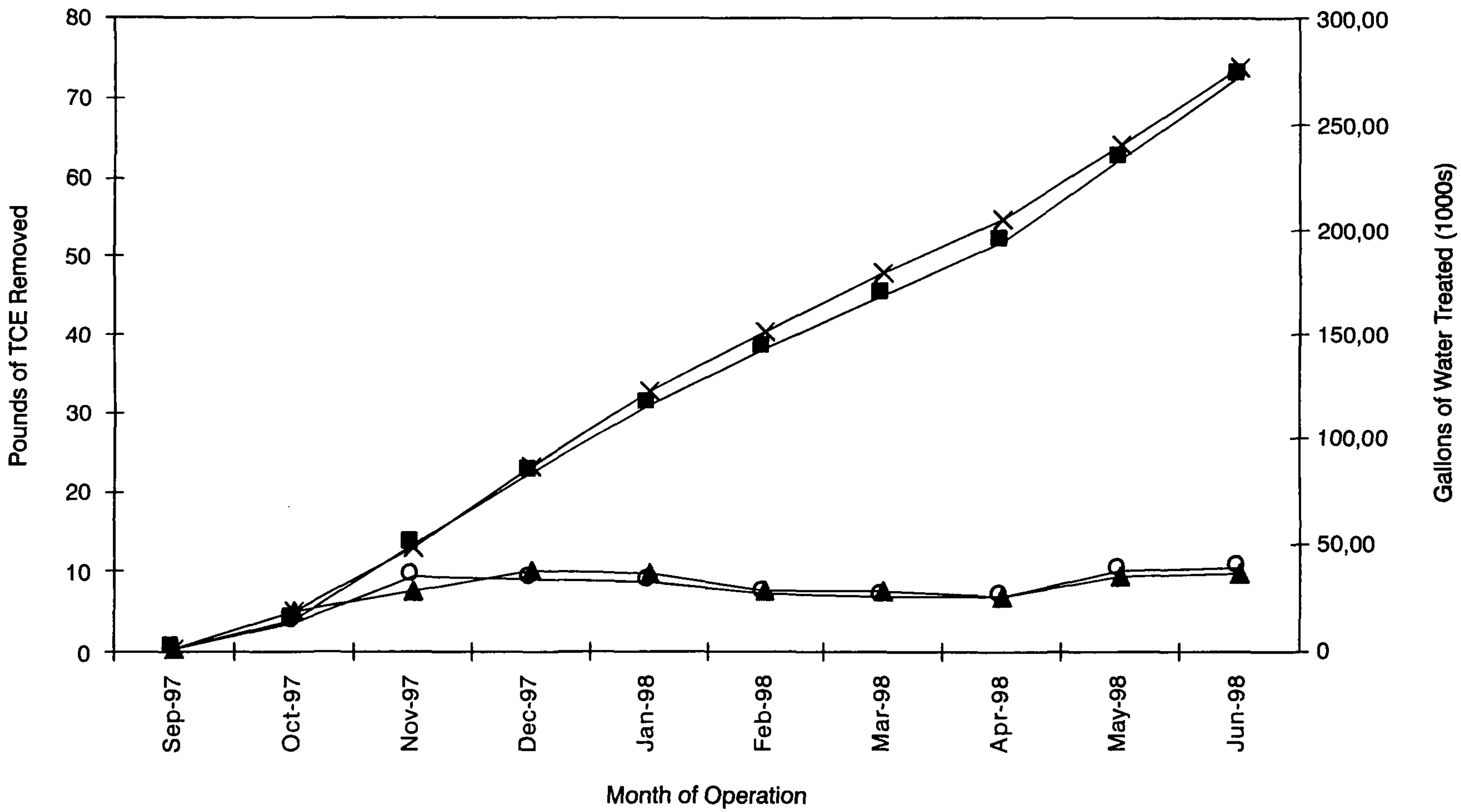
N

0 1200

Scale in Feet
1:14400

Estimated Plume Capture
for the Upper Subshallow Hydrostratigraphic Zone
Main Base Plume Remedial System, Second Quarter 1998

Five-Year Review
Castle Airport

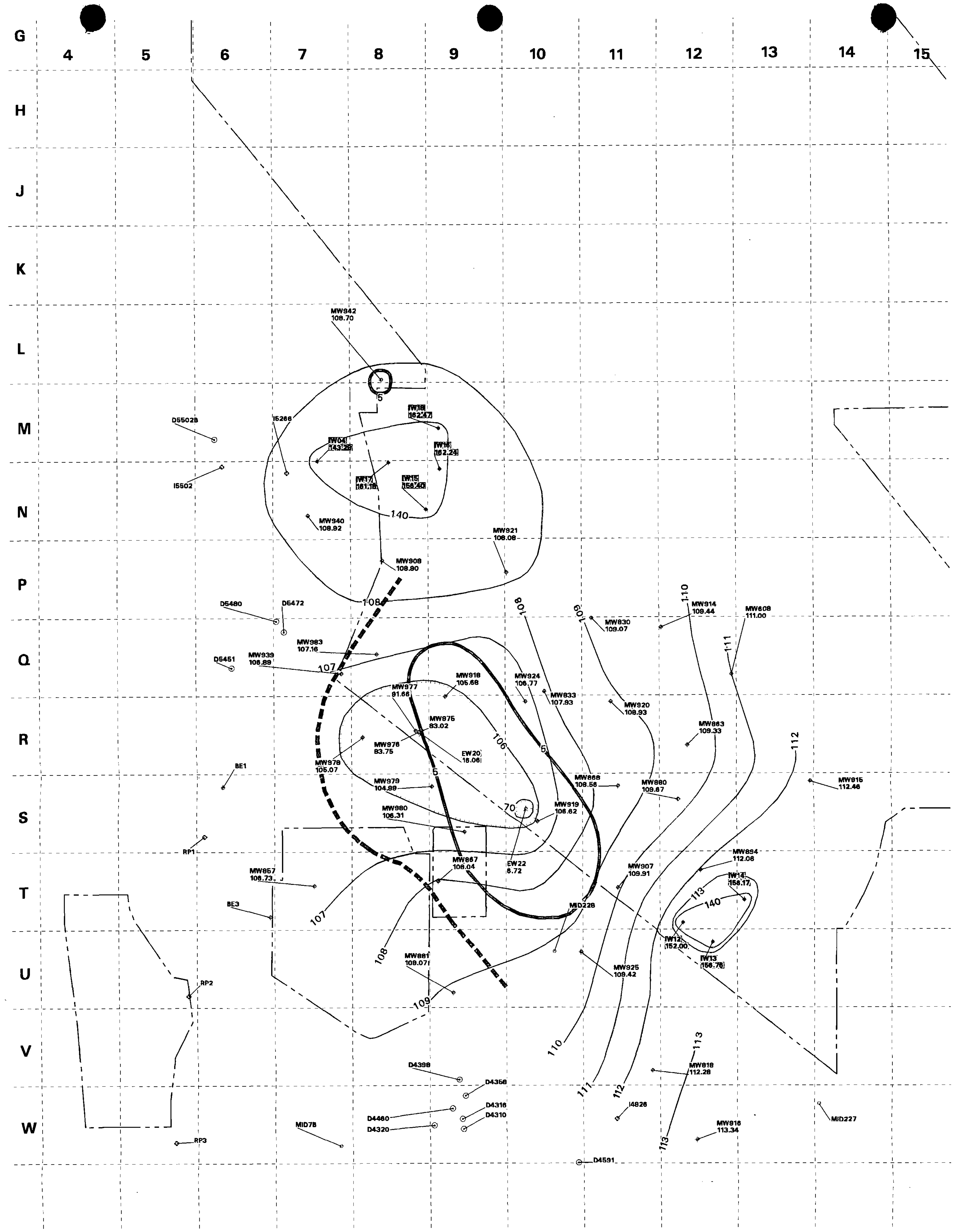


LEGEND

- TCE Removed Per Month (pounds)
- Cumulative TCE Removed (pounds)
- Treated Water per Month (1000s Gallons)
- Cumulative Treated Water (1000s Gallons)

Cummulative and Monthly Groundwater Treated and TCE Removed - Phase 2

Five-Year Review
Castle Airport



LEGEND

MW001	Monitoring well		Property boundary
D4740	Domestic well		Groundwater elevation contours in feet above mean sea level; dashed where inferred
I1-01	Irrigation well-private		
MID1	Irrigation well-public		
EW01	Extraction well		
JI6	Injection well	MW875 60 11	Well location with groundwater elevation data
AM11	Municipal well		
	Area of groundwater elevation drawdown		5 μg/L TCE isoconcentration contour (Q2/98)
			Estimated zone of capture

N

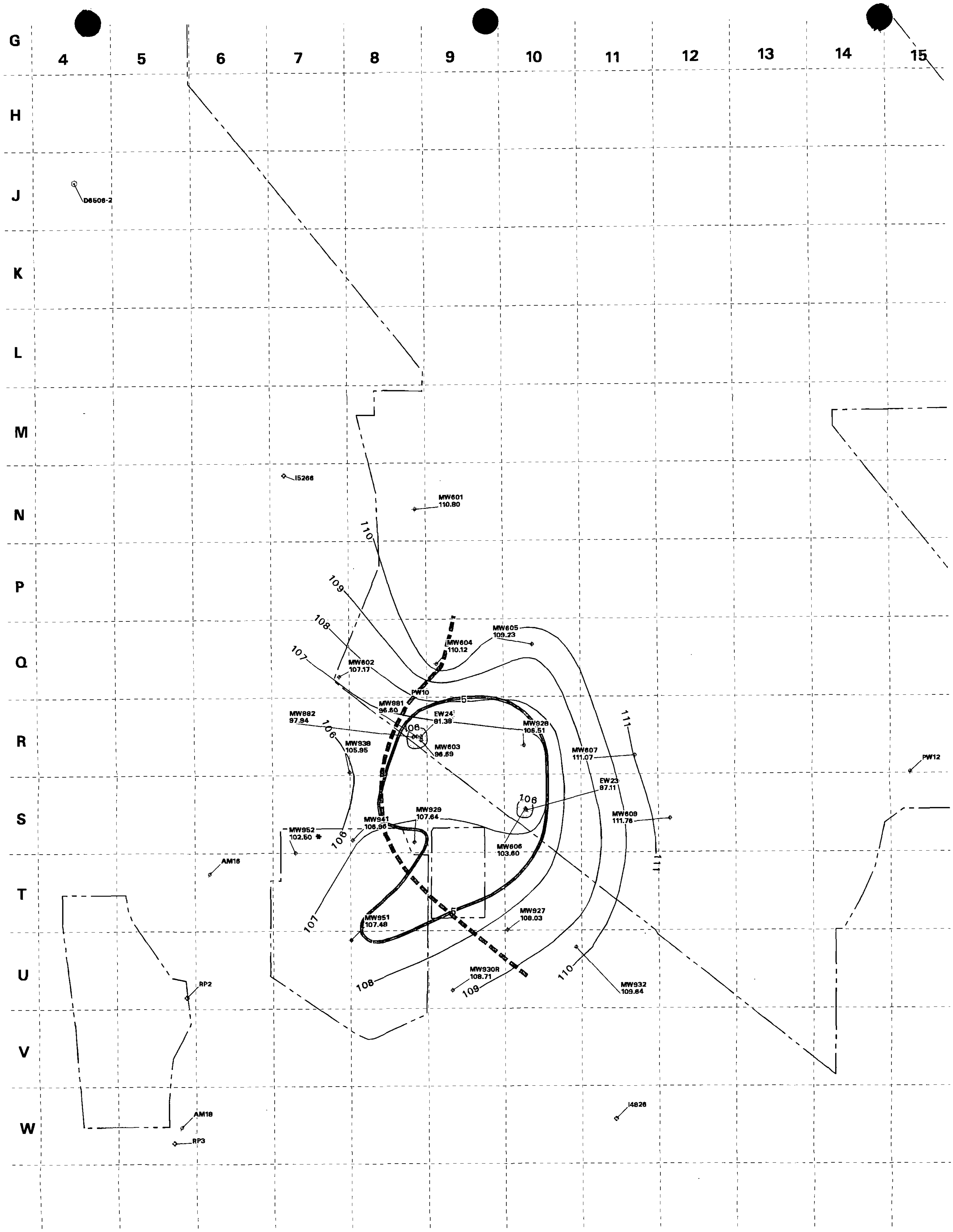
0 1200

Scale in Feet
1:14400

Estimated Plume Capture for the Lower Subshallow Hydrostratigraphic Zone Main Base Plume Remedial System, Second Quarter 1998

Five-Year Review
Castle Airport

11/11/98 lo /mnt1/gis/castle/ltgsp98/cap_zone.aml 27-K725-01 q298lsscap_zone.map



LEGEND

MW001	Monitoring well	Property boundary	* Data not used in contouring
D4740	Domestic well	Groundwater elevation contours in feet above mean sea level; dashed where inferred	
I1-01	Irrigation well-private		
MID1	Irrigation well-public		
EW01	Extraction well		
AM11	Municipal well	MW875 60.11 Well location with groundwater elevation data	
PW15	Production well		

Area of groundwater elevation drawdown

5 $\mu g/L$ TCE isoconcentration contour (Q2/98)

Estimated zone of capture

N

0 1200

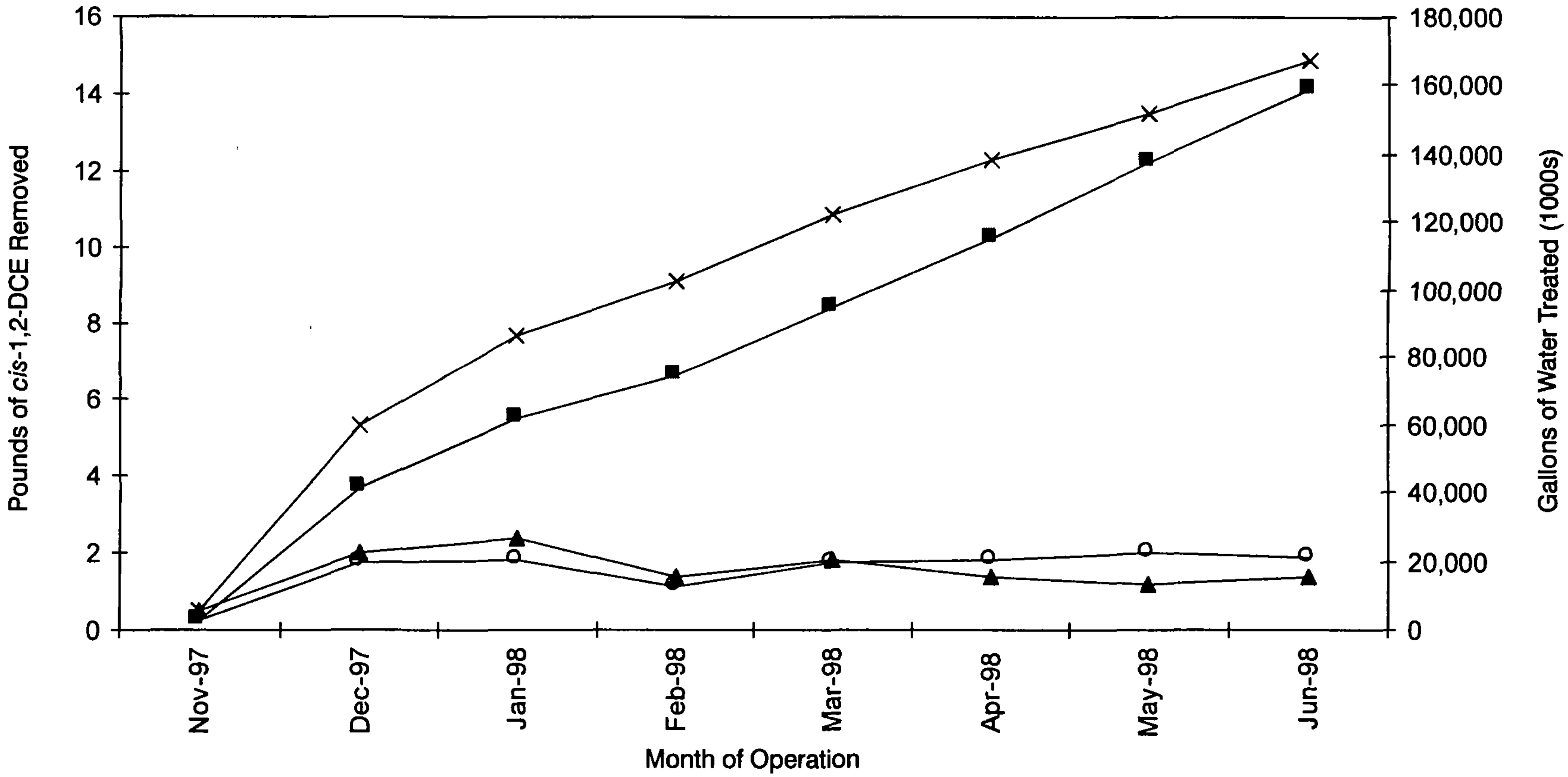
Scale in Feet
1:14400

Estimated Plume Capture
for the Confined Hydrostratigraphic Zone
Main Base Plume Remedial System, Second Quarter 1998

Five-Year Review
Castle Airport

11/11/98 lo /mnt1/gis/castle/ltgsp98/cap_zone.aml 27-K725-01 q298cfcap_zone.map

FIGURE 4-7

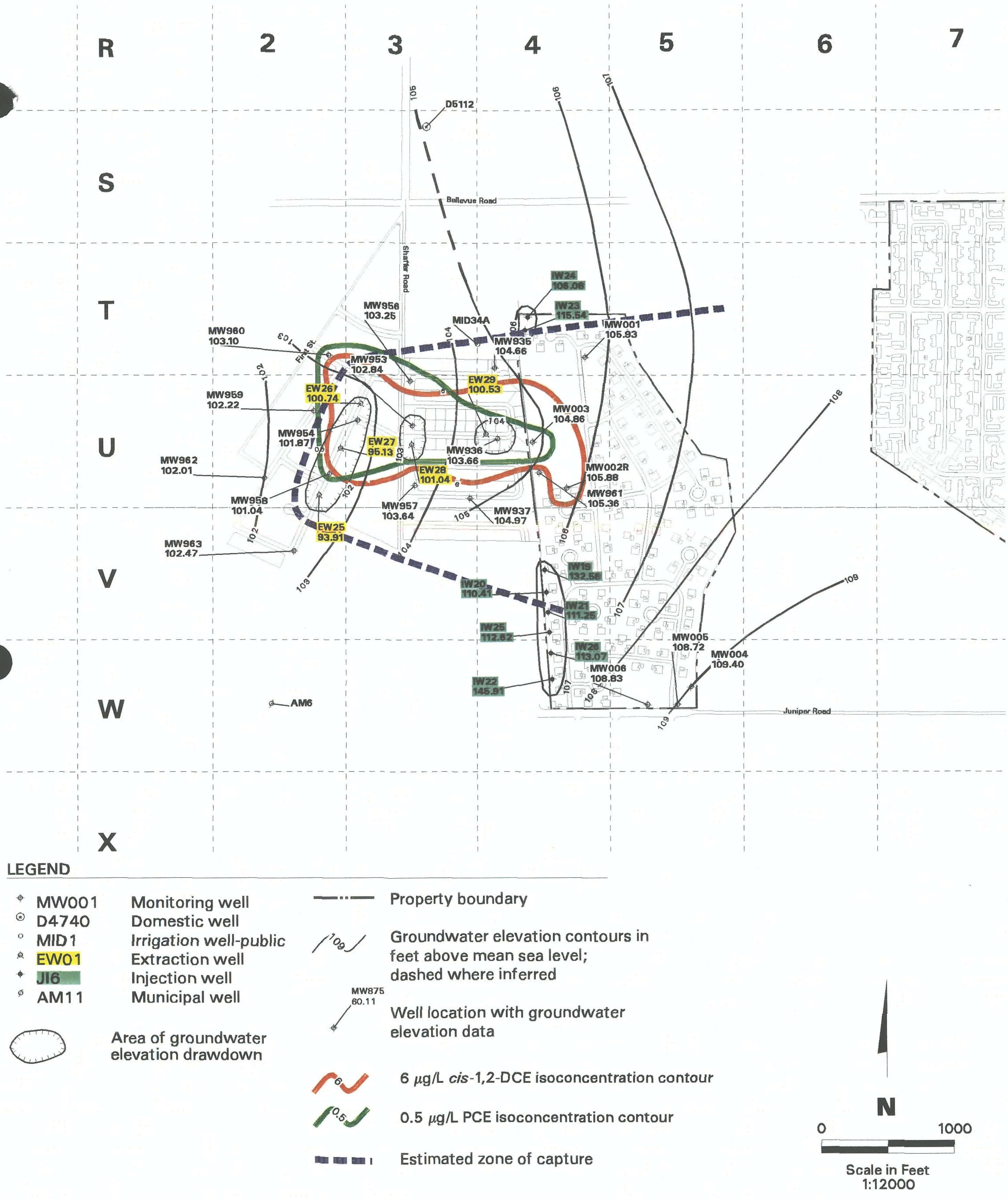


LEGEND

- *cis*-1,2-DCE Removed per Month (pounds)
- Cumulative cis-1,2-DCE Removed (pounds)
- Treated Water per Month (1,000s Gallons)
- Cumulative Treated Water (1,000s Gallons)

Cummulative and Monthly Groundwater Treated and *cis*-1,2-DCE Removed - Castle Vista

Five-Year Review
Castle Airport

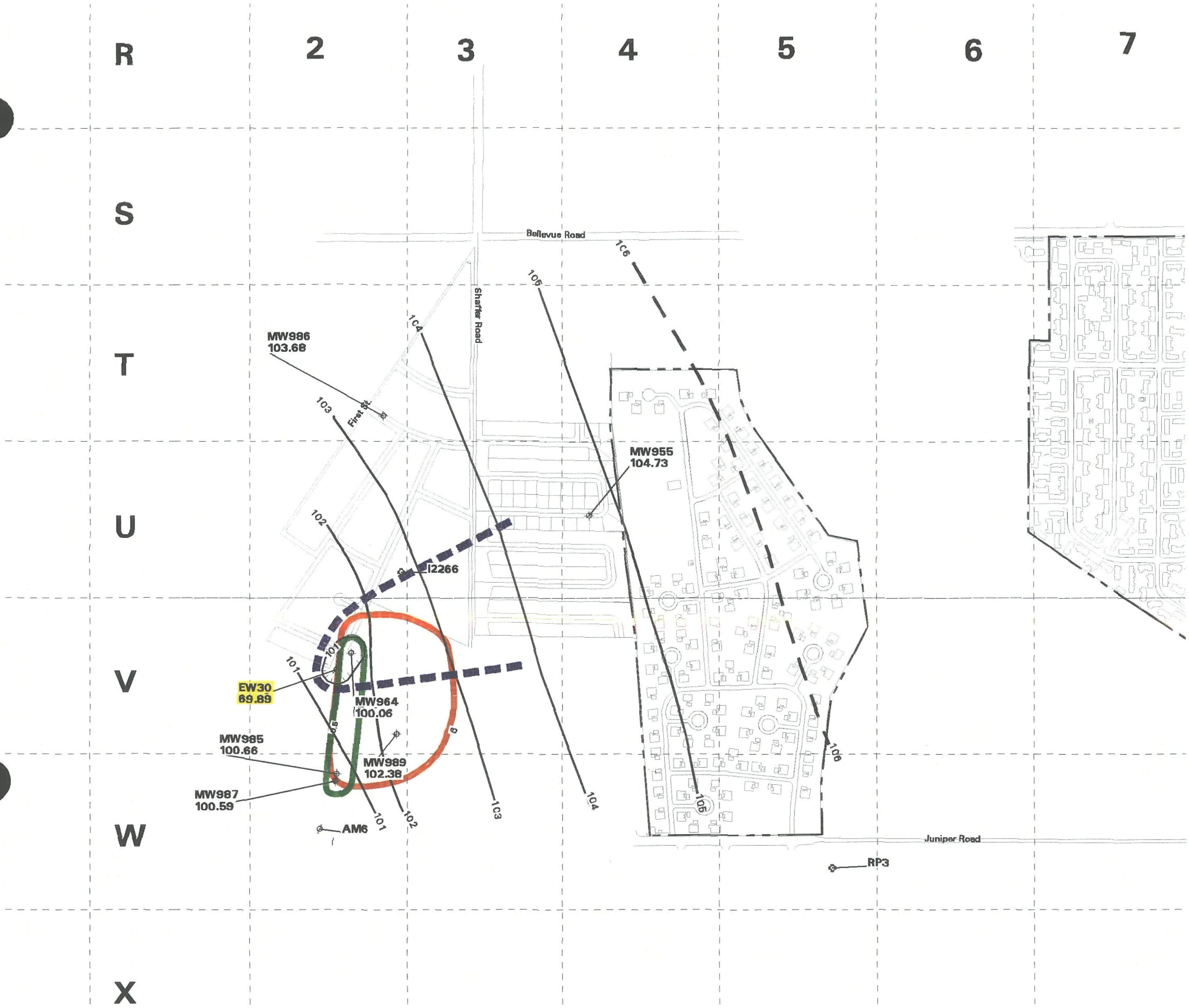


Estimated Plume Capture for the Shallow Hydrostratigraphic Zone Castle Vista Plume Remedial System, Second Quarter 1998

Five-Year Review
Castle Airport

11/11/98 lo /users/lorlando/gis/castle/teer/cap_zone_vista2.aml 27-K725-01 Q298scap_vista.map

FIGURE 4-9



LEGEND

MW001	Monitoring well		Property boundary
I1-01	Irrigation well-private		Groundwater elevation contours in feet above mean sea level; dashed where inferred
EW01	Extraction well	MW875 60.11	Well location with groundwater elevation data
AM11	Municipal well		

6 μg/L *cis*-1,2-DCE isoconcentration contour

0.5 μg/L PCE isoconcentration contour

Estimated zone of capture

Area of groundwater elevation drawdown

N

0 1000

Scale in Feet
1:12000

**Estimated Plume Capture
for the Upper Subshallow Hydrostratigraphic Zone
Castle Vista Plume Remedial System, Second Quarter 1998**

*Five-Year Review
Castle Airport*

11/11/98 lo /users/lorlando/gis/castle/teer/cap_zone_vista2.aml 27-K725-01 Q298usscap_vista.map

FIGURE 4-10

5. TECHNOLOGY REVIEW AND RECOMMENDATIONS

The following sections provide an overview of the technologies employed in the groundwater and vadose zone remedial actions at Castle Airport. Modifications to systems since startup and any planned expansions, upgrades, or modifications to operation to meet ROD objectives are discussed. Corrective actions, if any, identified during this five-year review are described. Corrective actions are necessary modifications to existing systems or system operation to maintain efficiency of remediation and/or so that they remain protective of human health and the environment. Planned system expansions or upgrades to fully meet ROD objectives (phased approach) are not considered corrective actions.

5.1 CB-PART 1 ROD

Technology reviews for the groundwater remedial actions at Castle Airport are presented following.

5.1.1 OU-1

The OU-1 groundwater treatment system employs pump-and-treat technology. Groundwater treatment is by dual-stage air stripping. Treated groundwater is reinjected. Minor modifications have been made to the system since startup in July 1994. During December 1995 and January 1996 and again during August 1998, corrective actions were taken to prevent the reoccurrence of discharge of untreated groundwater that occurred from September through early December 1995 and on 14 August 1998. These corrective actions are outlined in Section 4.1.1.5. During the spring of 1996, the carbon adsorption and solvent recovery unit was taken off line, and minor modifications were made to the treatment plant to improve operational reliability. One additional extraction well was installed and added to the system at that time to improve mass removal and seven piezometers were installed to improve effectiveness monitoring. Pumping rates at individual extraction and injection wells have been adjusted in the past and will continue to be adjusted (optimized) in the future to maintain or improve hydraulic capture and/or increase mass removal (proactive plume management). Such intermittent adjustments will become more critical as hydraulic conditions change and the mass of contaminants in the Main Base Plume is reduced. No other modifications have been made or are presently planned for OU-1 as an individual groundwater treatment system. This five-year review has not identified any corrective actions as being necessary at OU-1.

5.1.2 OU-2

The OU-2 groundwater treatment system employs pump-and-treat technology. Groundwater treatment is by liquid-phase GAC. Treated groundwater is reinjected. Other than minor modifications to the computerized control system, no modifications have been made to the system since startup in November 1996. During November 1997, one of the four carbon vessels at the OU-2 plant suffered an internal structure failure during a carbon changeout. Since this vessel represented excess capacity, there was no risk to human health or the environment and no specific corrective actions were taken within the O&M program. A number of injection wells have been redeveloped to maintain injection rates, but the wells have not been modified. The rate of carbon use for the OU-2 treatment system has been greater than assumed during design and for initial estimates of O&M costs. Similar to OU-1, pumping rates at individual extraction and injection wells have been adjusted in the past and will continue to be adjusted (optimized) in the future to maintain or improve hydraulic capture and/or increase mass removal (proactive plume management). Such intermittent adjustments will become more critical as hydraulic conditions change and the mass of contaminants in the Main Base Plume is reduced. No other modifications have been made or are presently planned for OU-2 as an individual groundwater treatment system. This five-year review has not identified any corrective actions as being necessary at OU-2 other than potential changes to address the rate of carbon use (see discussion of treatability study in Section 5.1.3) and finalization of a plan for periodic redevelopment of injection wells.

5.1.3 Phase 2

The Phase 2 groundwater treatment system employs the same technology as the OU-2 system. Other than minor modifications to the computerized control system, no changes or enhancements have been made to the system since startup in September 1997. During January 1998, corrective actions, in the form of changes to O&M procedures, were taken to prevent the reoccurrence of a surface spill of untreated groundwater such as happened at the Phase 2 plant in late December 1997. These corrective actions are outlined in Section 4.1.3.5.

The rate of carbon usage for the Phase 2 treatment system has been greater than assumed during design and for initial estimates of O&M costs. The Phase 2 plant consists of two pairs of modular GAC absorption units connected in series. Each pair consists of a 10,000-pound and a 20,000-pound vessel. One is the lead or primary pair of vessels for groundwater treatment and the second is the lag or secondary pair of vessels. Carbon changeout occurs when contaminant breakthrough of the primary vessels reaches approximately 25 percent of the influent concentration. At that time, the carbon is replaced in the primary vessel and the groundwater flow is rerouted so that the secondary vessels become the primary and vice-versa. On 3 March 1998, after approximately five months of operation (29 September 1997 to 3 March 1998), carbon in the primary pair of vessels (10,000-pound and 20,000-pound) at the Phase 2 treatment plant was changed due to DCE and TCE concentrations in the primary effluent.

Based on the influent chemical concentrations and flow rate at the Phase 2 treatment plant, the theoretical or calculated life of the carbon should be longer than the approximately six-month life observed. A treatability study is being conducted to assess the cause for the early saturation of the carbon and to evaluate cost-effective pre-treatment or other alternatives for extending the life of the carbon. An evaluation is also being conducted to determine if other chemical compounds in the groundwater may be competing for locations on the carbon. Adjustments and/or additions to the treatment train will be evaluated and analyzed for cost-benefit. This ongoing treatability study is scheduled for completion by early 1999. Based on study results, corrective actions may be implemented to decrease the carbon usage rate and, thereby, improve the cost effectiveness of groundwater remediation.

A number of the injection wells for Phase 2, all completed in the LSS HSZ, have exhibited diminished injection capacity with time, a condition very typical of injection wells. A number of the injection wells have been redeveloped; a few have been redeveloped up to three times. The cause of the diminished injection capacity is not readily apparent and, therefore, a number of redevelopment procedures have been employed. Procedures used to date include chemical treatment (chlorine, acid, and dispersants); swabbing; jetting; air lifting; and over-pumping. Field testing and office research continues to identify the nature of the plugging that is occurring and the most effective redevelopment procedures. It is considered likely that a maintenance program involving periodic redevelopment of most if not all of the existing Phase 2 injection wells will need to be initiated and that this will constitute the corrective action. The most effective redevelopment procedures for site-specific conditions will be identified and applied.

It is noted that the treatment capacity of the Phase 2 system has not been greatly affected by the periodic reductions in injection capacity. To maintain treatment capacity, excess treated water has been discharged to the Casad Lateral via the intertie to the OU-2 discharge system. This discharge was initiated on 12 May 1998 and is continuing as of the date of this review. The average monthly discharge rate has ranged from 405 gpm (May 1998) to 474 gpm (September 1998) and has generally increased with time to balance diminishing injection capacity. The maximum permitted surface discharge rate to the Casad Lateral (NPDES permit) is currently 500 gpm.

Pumping rates at individual extraction and injection wells have been adjusted in the past and will continue to be adjusted (optimized) in the future to improve hydraulic capture and/or increase mass removal (proactive plume management). As noted previously, such intermittent adjustments in pumping rates will become more critical as hydraulic conditions change and the mass of contaminants in the main base plume is reduced. No other modifications have been made to Phase 2 to date. A major expansion of the Phase 2 system is planned to address the issues of noncompliance with the CB-Part 1 ROD due to apparent lack of hydraulic control of the Main Base Plume, at least seasonally, in the USS, LSS, and Confined HSZs. This expansion is the Phase 3 remedial action (see Section 5.1.5).

This five-year review has not identified any corrective actions, other than possible modifications to reduce carbon usage (dependent upon treatability study results) and finalization of a plan for periodic redevelopment of injection wells, which are appropriate or necessary for the present Phase 2 system.

5.1.4 Castle Vista

The Castle Vista groundwater treatment system employs the same technology as the OU-2 and Phase 2 systems. Other than minor modifications to the computerized control system, no changes have been made to the system since startup in October 1997. Pumping rates at individual wells have been adjusted since startup (optimized) and will likely continue to be adjusted intermittently in the future.

Air Force plans to install a wellhead treatment (GAC) unit on City of Atwater municipal supply well AM6 are presently under discussion. This well is downgradient of the Castle Vista Plume (see Figure 3-22) and groundwater from the well has historically contained detectable concentrations of several VOCs, including *cis*-1,2-DCE. With wellhead treatment in place and the discharge meeting treated water discharge standards, the well would be considered part of the Castle Vista groundwater treatment system in that it would be being used as an extraction well for plume control and mass removal. Two to three new monitoring wells will be installed to assess plume conditions in the vicinity of AM6. No other modifications are presently planned.

Similar to OU-2 and Phase 2, the rate of carbon usage for the Castle Vista treatment system has been greater than assumed during design and for initial estimates of O&M costs. The Castle Vista plant consists of two 20,000-pound GAC vessels connected in series and is operated with a lead and a lag vessel. On 27 February 1998, the carbon in both vessels was replaced because *cis*-1,2-DCE was detected in the secondary effluent sample on 18 February 1998. *cis*-1,2-DCE was detected in the effluent from the primary or lead vessel on 6 January 1998. After only about four months of operation (27 October 1997 to 18 February 1998), 40,000 pounds of carbon was used by the system.

The ongoing assessment of carbon usage (treatability study) mentioned under the discussion of Phase 2 is also addressing the carbon usage at Castle Vista.

This five-year review has not identified any corrective actions, other than possible modifications to reduce carbon usage (dependent upon results of treatability study), which are appropriate or necessary for the present Castle Vista system.

5.1.5 Phase 3

A Phase 3 remedial action has been recommended (draft TEER; Jacobs, 1998b). The primary purpose of the Phase 3 remedial action is to ensure that the remedial system for the Main Base Plume provides complete hydraulic control of the plume during all seasons and in all HSZs. Additional benefits of Phase 3 will be an improvement in mass removal rates and a potential reduction in the remediation schedule. Final design and construction of Phase 3 are not scheduled until late 1999 through mid 2000.

Initial recommendations indicate that Phase 3 will be an expansion of the existing Phase 2 system and thus will employ pump-and-treat technology with groundwater treatment by liquid-phase GAC. In addition to expansion of the existing Phase 2 treatment plant (treat approximately 815 gpm additional flow), recommendations for Phase 3 call for eight extraction wells, 12 injection wells, and two monitoring wells. Five of the recommended extraction wells will be completed in the USS HSZ, two in the LSS HSZ, and one in the Confined HSZ. No new extraction wells are recommended for the Shallow HSZ. Two of the recommended injection wells will be completed in the Shallow HSZ, seven in the USS HSZ, and three in the LSS HSZ. The two recommended monitoring wells will be completed in the LSS HSZ. It is possible that final recommendations for Phase 3 may differ from those stated here due to the review process and the fact that additional monitoring data will continue to be collected and effectiveness evaluations updated.

This five-year review has not identified any corrective actions for Phase 3; the system is not in place.

5.2 SCOU ROD

The SCOU ROD (potentially now two RODs) is not final and vadose zone remedial actions have not been initiated to date at Castle Airport. Technology reviews of vadose zone remedial actions at Castle Airport will be provided in subsequent five-year reviews. Technologies employed in ongoing removal actions and likely to be employed in final vadose zone remedial actions include:

- Soil vapor extraction
- Bioventing
- Natural attenuation (biodegradation)
- Capping
- Consolidation and capping
- Excavation and on- or off-site disposal
- Institutional controls
- No action

5.3 CB-PART 2 ROD

The CB-Part 2 ROD will be addressed in future five-year reviews.

5.4 INSTITUTIONAL CONTROLS

There are no institutional controls currently in place as a part of CERCLA remedial actions at Castle Airport. The CB-Part 1 ROD does not specify institutional controls as a component of the remedial actions for groundwater contamination. Institutional controls may be included as a component of final remedial actions for certain SCOU sites. These sites, and the nature of any associated institutional controls, will be identified in the final SCOU ROD(s). Institutional controls may also be included as a component of final remedial actions for certain sites with interrelated vadose zone and groundwater contamination. These sites, and the nature of any associated institutional controls, will be assessed in the CB-Part 2 RI/FS and specified in the final CB-Part 2 ROD.

Subsequent five-year reviews will provide an assessment of institutional controls in place at Castle Airport for SCOU sites or sites with interrelated vadose zone and groundwater contamination. The assessments will be incorporated in the discussions in Section 4 (Remedial Objectives) and Section 5 (Technology Review and Recommendations). At a minimum, discussions of individual sites will state whether or not institutional controls are identified as a component of the remedy. The nature and effectiveness of any imposed institutional controls will be discussed. Corrective actions will be identified for any sites where the existing institutional controls may not be effective in eliminating unreasonable risk to human health or the environment.

5.5 Community Involvement

An active community involvement program has been maintained throughout the CERCLA process at Castle Airport. General activities have included establishment of a Restoration Advisory Board (RAB), periodic publication of fact sheets and a newsletter (EnviroProgress), and public hearings and meetings prior to large-scale field investigation or construction activities, especially those in off-base areas.

The process followed during planning, design, and construction of the Castle Vista groundwater treatment system provides a recent example of the commitment to public involvement. Specific activities included:

- Held a public hearing on proposed plan (23 July 1996).
- Provided notification to Thomas Olaeta Elementary School (18 November 1996).
- Met with the staff of Thomas Olaeta School (4 December 1996).
- Provided a door-to-door informational campaign in affected neighborhood prior to start of field investigation (December 1996).
- Presented at a Parent Teacher Association meeting (20 March 1997).
- Held a public meeting at the school to discuss field investigation results (8 May 1997).
- Distributed 280 flyers door-to-door, summarizing field investigation results (May 1997).
- Provided field investigation results to the RAB (May 1997).
- Prepared and distributed fact sheets and newsletters throughout the process outlining program status and study results.

A newsletter explaining the purpose and components of the five-year review process was distributed in May 1998. The current five-year review will be distributed to the RAB when the document is final (all signatures on declaration page). A presentation on the review will be held at the first RAB meeting following distribution. The five-year review document will also be included in the site administrative record and copies provided in the established locations for the public to view.

The level of remedial activity at Castle Airport will decline in the future in that there will be less field investigation and construction work, although long-term monitoring and O&M of existing remedial actions will continue. Community involvement activities will likely be reduced to match the decline in new remedial activity (e.g., the RAB will be disbanded at some time). To maintain a level of community involvement through what may be termed an "operational" period, the Air Force proposes at a minimum to:

- Provide the public with the opportunity to comment on the planned timing and the general scope of future five-year reviews by publishing a summary of them in the CB-Part 2 Proposed Plan.
- Notify the public of pending five-year reviews just prior to their occurrence and publication.
- Make all five-year reviews available to the public in the administrative record.

The status and nature of public involvement in the remedial program at Castle Airport will be updated in each subsequent five-year review.

6. STATEMENT ON PROTECTIVENESS

6.1 GROUNDWATER REMEDIAL ACTIONS

The groundwater remedial actions selected and implemented at Castle Airport remain protective of human health and the environment but do not yet fully meet the objectives of the CB-Part 1 ROD.

The groundwater remedial actions at Castle Airport remain protective of human health and the environment because these actions, in concert with other steps undertaken by the Air Force, have effectively eliminated exposure pathways to untreated groundwater. Specific results and steps taken include:

- The existing Main Base Plume remedial system has minimized, if not eliminated further downgradient and off-base plume migration.
- The existing Castle Vista Plume remedial system appears to have eliminated further downgradient migration of the plume in the Shallow HSZ. The plume in the USS HSZ continues to affect City of Atwater municipal supply well AM6. However, concentrations of the primary contaminant (*cis*-1,2-DCE) in well discharge (typically 0.6 to 0.9 μg/L) are significantly less than the MCL (6 μg/L) and state drinking water standards are not being violated. The Air Force has proposed to place a wellhead treatment unit (GAC) on AM6, which is at the downgradient edge of the plume in the USS HSZ. Wellhead treatment will allow the well to be designated an extraction well for hydraulic plume control. An additional benefit will be further protectiveness of human health by reducing the concentration of *cis*-1,2-DCE in well discharge to CB-Part 1 ROD treated water discharge standards i.e., less than 0.5 μg/L.
- Discharges from the remedial systems meet established standards (CB-Part 1 ROD discharge standards for treated groundwater for OU-2, Phase 2, and Castle Vista and ambient air standards for OU-1).
- The Air Force has requested and the City of Atwater has agreed to reduce the pumping of municipal supply well AM16 to minimize the potential for induced migration of contaminated groundwater.
- A base water supply line was extended along Wallace Road in 1989 to provide an uncontaminated water supply to three residences near the base boundary.
- The Air Force has installed GAC treatment units at several additional off-base domestic wells with detectable levels of groundwater contamination.
- Routine monitoring of all domestic wells immediately downgradient of the Main Base Plume is conducted under the LTGSP.

The discussions in Sections 4 and 5 identified areas of noncompliance for the ongoing groundwater remedial actions at Castle Airport. Specifically, the results of effectiveness evaluations conducted for, and presented in, the draft TEER and summarized in Section 4, noted the following areas of noncompliance:

- The existing Main Base Plume remedial system does not provide, at least seasonally, full hydraulic control of the plume in the USS, LSS, and Confined HSZs.
- The existing Castle Vista Plume remedial system does not provide full hydraulic control of the plume in the USS HSZ.
- Neither of the existing remedial systems has, to date, met the other primary CB-Part 1 ROD objective, which stipulates groundwater cleanup to the MCL of the primary contaminant in each plume.

The Air Force is taking the steps necessary to fully meet the CB-Part 1 ROD objective of hydraulic control of the Main Base Plume by continuing the phased approach to groundwater remediation. Recommendations have been developed for a Phase 3 remedial action. These recommendations were developed and described in detail in the draft TEER (Jacobs, 1998b) submitted for regulatory review on 9 October 1998. In summary, initial recommendations for Phase 3 include construction of eight extraction wells, 12 injection wells, two monitoring wells, and expansion of the existing Phase 2 treatment plant and conveyance system to handle an additional 815 gpm. Corrective actions that may result from ongoing studies include a plan for periodic redevelopment of injection wells and changes to treatment plant configuration or operation to increase carbon life. These actions, if implemented, will improve the efficiency of remediation but will not directly help achieve any specific CB-Part 1 ROD objective.

The Air Force has proposed installation of wellhead treatment at City of Atwater municipal supply well AM6. This will allow for designation of AM6 as an extraction well for the Castle Vista groundwater treatment system. The results of modeling studies conducted for the TEER have shown that use of AM6 as an extraction well will provide full hydraulic control of the plume in the USS HSZ.

The CB-Part 1 ROD objective of groundwater cleanup to the MCL is the ultimate objective of groundwater remediation and defines the completion of groundwater remediation. The

CB-Part 1 ROD did not establish a remediation schedule, but it is understood that achieving MCLs is a long-term goal and would not be expected to be achieved at this stage in the remedial process.

6.2 VADOSE ZONE REMEDIAL ACTIONS

Vadose zone remedial actions have not been implemented at Castle Airport because the SCOU ROD or RODs are not final. Although remedial actions have not been implemented, removal actions have been initiated at the most highly contaminated SCOU sites i.e., those that pose the greatest risk to human health or the environment. Protectiveness of vadose zone remedial actions will be evaluated in subsequent five-year reviews.

7. SCHEDULE FOR OUT-YEAR REVIEWS

Table 7-1 lists significant dates/milestones associated with the groundwater and vadose zone remedial actions at Castle Airport. The Air Force and the EPA have agreed that the trigger date for policy reviews at Castle Airport is the construction start date for the initial remedial action. Construction was started on the OU-1 groundwater treatment system in March 1993 and preparation of the first five-year review for Castle Airport began in March 1998. The next five-year review will be conducted and a report submitted by March 2003. Reviews will continue to be conducted every five years (March 2008, March 2013, etc.) until all groundwater and vadose zone remedial actions at Castle Airport are complete.

A master list of sites (vadose zone and groundwater) and remedial actions at Castle Airport will be prepared and included in all subsequent five-year reviews. This list, which will be similar to Table 2-2, will help establish the scope of future reviews i.e., NFA sites would not need to be evaluated or even discussed.

Table 7-1
Summary of Dates and Proposed Schedule for Five-Year Reviews

ROD/ Remedial Action	ROD Date	Remedial Actions			Initial 5-Year Review[1]	Subsequent 5-Year Reviews[1]
		Start Construction	End Construction	Start Operation		
OU-1[2]/OU-1	8/91	3/93	5/94	6/94	3/98[3]	Every five years thereafter, until all remedial actions completed (3/03, 3/08, etc.)
OU-2[2]/OU-2	12/94	3/95	10/96	11/96		
CB–Part 1/Phase 2	1/97	3/97	9/97	9/97		
CB–Part 1/Castle Vista	1/97	3/97	10/97	10/97		
CB–Part 1/Phase 3	1/97	Late 1999	Mid 2000	Mid 2000		
SCOU/SCOU Sites	9/00	TBD	TBD	TBD		
CB–Part 2/TBD	TBD	TBD	TBD	TBD		

Notes
[1]Assumed all reviews except for final will be Type Ia
[2]CB–Part 1 ROD supersedes the OU-1 and OU-2 RODs
[3]Initial review five years from start of construction of OU-1

OU	Operable Unit
ROD	Record of Decision
SCOU	Source Control Operable Unit
TBD	To be determined

8. REFERENCES

This section lists documents cited in the text and all documents reviewed for general background and preparation of the five-year review.

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Appendix A
Response to Comments

Response to EPA Comments on the Initial Five-Year Review

This response will, for convenience, repeat EPA's comments in standard type followed by the Jacobs Engineering response in bold type.

Overall, the document is comprehensive and clearly written. EPA's comments principally address clarifications to the text in portions of the document. These comments need to be addressed before EPA can concur on the Review.

EPA's review did not include a thorough, independent verification of the effectiveness of contaminant plume capture in groundwater underlying the Base and proposed future remedial actions. The Review attests to the Operable Unit 1 (OU-1) and Operable Unit 2 (OU-2) treatment systems achieving capture of portions of the Main Base Plume (Sections 4.1.1.2 and 4.1.2.2, pp. 4-6 and 4-9). We intend to conduct such an assessment as part of our review of the Phase 2 Technical and Economic Evaluation Report (TEER), which is scheduled for submittal in September 1998 and is expected to include a comprehensive evaluation of the effectiveness of the existing Castle Airport groundwater treatment systems.

Concerns

1. [General] Per EPA guidance, Five-Year Reviews should include a signed EPA determination of whether: 1) the remedy (or remedies) remains protective of human health and the environment; 2) the remedy is functioning as designed; and 3) the necessary operation and maintenance is being performed. EPA recommends that a declaration page, with signature blocks for EPA (Daniel D. Opalski, Chief, Federal Facilities Cleanup Branch), the Air Force, and the State of California, be added to the front of the document attesting to this determination.

   Response: A "declaration" page has been added following the document's title page. The declaration addresses the three items listed in the comment. Signature spaces are provided for the Air Force, for the USEPA, and for the California EPA (DTSC).

2. [Section 4, Remedial Objectives] The information on the groundwater remedial actions presented in Section 4 does not appear to support the conclusion in Section 6 (Statement on Protectiveness) that "the groundwater remedial actions ... do not fully meet the objectives of the CB Part 1 ROD (Comprehensive Basewide Part 1 Record of Decision)." Sections 4.1.1.5, 4.1.1.6, 4.1.3.5, and 4.1.4.5 (Areas of Noncompliance) include statements that "no areas or aspects" of the operation of the four groundwater treatment systems "have been identified as noncompliant with the CB Part 1 ROD." Section 4 implies that the objectives of the CB Part 1 ROD either have been fully met (for OU-1 and OU-2), or are currently under evaluation (for Phase 2 and Castle Vista), and that no additional changes to the systems are required at this time.

Response: Section 4 has been extensively revised and now includes summary results from the effectiveness evaluations of OU-1, OU-2, Phase 2, and Castle Vista presented in the draft TEER. These effectiveness evaluations suggested that the Main Base Plume remedial system, at least seasonally, is likely not providing full hydraulic control of the plume in the USS, LSS, and Confined HSZs. These evaluations also documented that the Castle Vista Plume remedial system, as presently configured, is not providing full hydraulic control of the plume in the USS HSZ. Neither system has, to date, met the CB-Part 1 ROD objective of cleanup of groundwater to MCLs, but this is a long-term objective not expected to be met at this point in the remediation process.

The discussion in Section 4 needs to be reconciled with the discussion in Section 6. The apparent inconsistency probably could be resolved by more clearly explaining that the objectives of the CB Part 1 ROD have not been fully met because the remedy, which includes a three-phased approach, has not been fully implemented. Further discussion of this issue is presented below in comment 4A.

Response: The discussions in Section 4 and 6 have been extensively revised and are now consistent. The areas of noncompliance mentioned in the

response to the first portion of this comment are carried through and discussed in Section 6. The recommended Phase 3 remedial action (draft TEER) is identified as the response to the areas of noncompliance (lack of complete hydraulic control) of the Main Base Plume. The already proposed installation of wellhead treatment on AM6 is identified as the response to the area of noncompliance (also lack of complete hydraulic control) of the Castle Vista Plume. Lack of compliance with cleanup of groundwater to MCLs need not be addressed at this time; there is no expectation at this point in the remediation process.

3. [Section 4.1.1.5, OU-1 Areas of Noncompliance; Section 4.1.2.5, OU-2 Areas of Noncompliance; Section 4.1.3.5, Phase 2 Areas of Noncompliance] The following events were not addressed in the discussions of areas of noncompliance:

OU-1 System. The exceedance of discharge standards that occurred during September to November 1995.

Response: A detailed discussion of this event, including the corrective actions implemented to prevent reoccurrence, has been incorporated in Section 4.1.1.5.

OU-2 System. The mechanical failure that occurred at one of the carbon units in November 1997. This event was documented in the Air Force report, *OU-2 Groundwater Treatment System Problem Analysis Report* (Jacobs Engineering, March 1998).

Response: A brief discussion of this event has been added to Section 4.1.2.5. No corrective actions were implemented as a result of this event because the carbon unit that experienced the failure represented excess system capacity. Consequently, the failure did not affect treatment capacity and did not result in increased risk to human health or the environment.

Phase 2 System: The spill of untreated groundwater that occurred on 30 December 1997. This event was documented in the Air Force report, *Phase 2 Groundwater Treatment System Problem Analysis Report* (Jacobs Engineering, January 1998).

Response: A detailed discussion of this event, including the corrective actions implemented to prevent reoccurrence, is incorporated in Section 4.1.3.5.

Any operational problems or mechanical failures that may have compromised the protectiveness of the remedy should be discussed. The problems that occurred at the OU-1 and Phase 2 systems appear to fall into this category. The text under "Areas of Noncompliance" should summarize the problem analyses that were conducted and the corrective actions that were implemented in response to these events. The problem that occurred at the OU-2 system does not appear to fall into this category, although if this is not the case, text describing the response actions also should be added.

Response: Discussion of all three events has been added to the appropriate portion of text in Section 4.1. As noted in the comment, the events at the OU-1 and Phase 2 treatment plants resulted in the preparation of Problem Analysis Reports and the implementation of corrective actions. No corrective actions were implemented in response to the carbon vessel failure at the OU-2 treatment plant.

4A. [Section 6, Statement on Protectiveness (p. 6-1)] The discussion of groundwater remedial actions in Section 6 needs to be expanded to clarify how the objectives of the CB Part 1 ROD have not been fully met. Section 6 states that "the groundwater remedial actions selected and implemented at Castle Airport remain protective of human health and the environment but do not fully meet the objectives of the CB Part 1 ROD." However, no further detail about the objectives (unmet or otherwise) is presented. Section 6 needs to specify the:

Objectives of the CB Part 1 ROD which have not been met (e.g., Phase 3 not implemented, MCLs not reached, etc.);

Reasons why these objectives have not been met; and

Steps that are planned to ensure full compliance with the ROD objectives.

This section essentially should present a summary of the conclusions presented in preceding Sections 4 and 5.

Response: Section 6 has been expanded and now provides a complete summary of the results of system operation and effectiveness evaluations presented in Sections 4 and 5. The discussion identifies the specific objectives of the CB-Part 1 ROD which have not been met (complete hydraulic control of the plumes and cleanup of groundwater to MCLs). The discussion also identifies why these objectives have not been met and what steps are planned to ensure full compliance with the CB-Part 1 ROD (implement Phase 3 and install wellhead treatment on AM6). The discussion further states that cleanup of groundwater to MCLs is a long-term objective and that there is no expectation that this objective will be met until much later in the remedial program.

4B. The Review should explain how the groundwater remedial actions "remain protective of public health and the environment" although they "do not fully meet the objectives of the CB Part 1 ROD." Specifically, the Review should explain how the Air Force has addressed potential exposures. This could be accomplished by including a discussion of the steps that have been taken to interrupt potential exposure pathways, such as exposures to untreated groundwater (for example, in municipal wells and other discharge points) and hazardous wastes (emissions) generated by remedial actions. For example, the Air Force has installed carbon treatment units at several off-base wells, and conducts routine monitoring under to the Long-Term Groundwater Sampling Program (LTGSP).

Response: Section 6 has been expanded to provide a summary discussion and specific examples of how the groundwater remedial actions at Castle Airport remain protective of human health and the environment. The general discussion focuses on the concept that the remedial actions and associated activities have effectively eliminated potential exposure pathways to contaminated groundwater. Specific examples listed and discussed include the reduction in AM16 pumping, the base water line extension along Wallace Road used to supply three residences, the installation of wellhead treatment units on several domestic wells, and the routine monitoring of domestic wells downgradient of Castle Airport conducted under the LTGSP.

4C. EPA recommends that the following statement (or an equivalent statement) be added to the discussion of vadose zone remedial actions in Section 6: "Although remedial actions have not been implemented, removal actions have been initiated at the most highly contaminated Source Control Operable Unit (SCOU) sites that pose the greatest risks."

Response: The suggested statement has been added to the brief discussion of vadose zone remedial actions in Section 6.

5. [Section 7, Schedule for Out-Year Reviews (p. 7-1)] EPA recommends that, once the Comprehensive Basewide Part 2 Record of Decision (CB Part 2 ROD) is final, the Castle Airport project team prepare a master list of sites and corresponding remedial actions and institutional controls to be reviewed in subsequent Five-Year Reviews. This list will lay the groundwork for subsequent Reviews so the need to define their scope will be minimized. For example, Table 1-2 (Inventory of SCOU Sites) could be updated to specify the selected remedial actions and the sites that will require evaluation. Sites specified for no further action can be omitted from further evaluations. If the Air Force agrees that this approach would be beneficial, the text in Section 7 should be amended to explain that the project team will prepare such a master list and provide an estimate of the time frame for completing this list.

Response: The text in Section 7 has been modified to indicate that the Air Force will prepare a master list of sites and corresponding remedial actions for Castle Airport. The list will be similar in style and content to Table 2-2 in the current five-year review, but will include groundwater remedial actions as well as vadose zone sites and will list the nature of all remedial actions. The list will be completed just prior to, and will be included in, the next (March 2003) and all subsequent five-year reviews.

6A. [Community Involvement] The Review should include a discussion of the community involvement activities that were conducted in connection with the review. EPA acknowledges that, in preparing the Review outline, the inclusion of a section on community involvement was overlooked. The Air Force, however, has completed several related community involvement activities, which have adequately fulfilled EPA's expectations. These activities included (or will include) the following, which should be discussed in the Review:

Distribution of a news letter (*EnviroProgress*, May 1998) explaining the purpose and components of the Review to community members;

Discussion of the Review at a Restoration Advisory Board (RAB) meeting;

Distribution of copies of the Review to RAB community members;

Inclusion of the Review in the site Administrative Record;

Conduction of community interviews in 1997 and 1998 in preparation for and during installation of groundwater treatment systems; and

Holding community meetings at Atwater High School and Thomas Oleata Elementary School to discuss groundwater remediation. (The dates of these meetings should be specified.)

Response: A new section (Section 5.5) has been added to the five-year review to address the issue of community involvement. The section identifies general community involvement activities that have been conducted throughout the CERCLA process at Castle Airport. A detailed listing of events that occurred during the planning, design, and construction of the Castle Vista groundwater treatment system is provided as a recent example of the level of community involvement activities typical of the Castle Airport program. Specific community involvement activities (past and future) related to this five-year review are listed.

6B. The Review should describe, at least very generally, how the Air Force plans to involve the community in future reviews. EPA is aware that numerous changes to the Air Force environmental program will occur in the next couple of years as the last remedial action in place (RIP) is achieved. These changes will likely be reflected in a somewhat reduced role of the Air Force community involvement program. The most significant change may involve the disbanding of the RAB, which is currently the most important forum for community input into the cleanup process. In implementing these changes, the Air Force needs to develop a communication strategy for Five-Year Reviews (and during long-term remedial action and monitoring).

A discussion of public participation should be included in the Review to demonstrate the Air Force's commitment to continued involvement of the community in the cleanup process. It may be appropriate to include this discussion in Section 7 (Schedule for Out-Year Reviews). EPA recommends that this discussion state, at a minimum, that the Air Force will:

Provide the public with an opportunity to comment on the planned timing and general scope[1] of future Five-Year Reviews by publishing a summary of them in the Comprehensive Basewide Part 2 Proposed Plan;

Notify the public of pending reviews just prior to their occurrence; and

Make all reviews available to the public in the Administrative Record.

Response: See response to Comment 6A. The final paragraph of the new section on community involvement outlines the program that the Air Force proposes to maintain, at a minimum, through the "operational period" of remediation at Castle Airport. This program matches that suggested by the EPA in the text of Comment 6B.

7. [Institutional Controls] The Review needs to present a more complete status update of institutional controls being (or not being) implemented at Castle Airport. The introduction in Section 1.1 states that institutional controls will be considered in evaluating the protectiveness of remedial actions (p.1-1), however, no other discussion of institutional controls is presented.

EPA is aware that no institutional controls are currently in place at Castle Airport, and, therefore, an evaluation of their effectiveness is premature. However, to address EPA's concern, it is recommended that a new section (such as Section 5.4), titled "Institutional Controls," be added to the Review. The new section should provide the following status information for the site:

- Institutional controls are not currently being implemented at Castle Airport.
- The CB Part 1 ROD does not specify institutional controls as a component of the remedial actions for groundwater contamination.

[1]The general scope will be based on the review "Types" (e.g., I, Ia, etc.) described in EPA guidance.

- Institutional controls will be included as a component of the remedial actions for certain SCOU sites. These sites and the corresponding institutional controls will be identified in the final SCOU ROD.
- Institutional controls (for sites with soil and groundwater contamination) may be included as a component of the remedial actions specified in the CB Part 2 ROD. The need for institutional controls will be evaluated as part of the CB Part 2 Remedial Investigation/Feasibility Study.

For subsequent Five-Year Reviews, a monitoring plan for institutional controls should be in effect, and an evaluation of how the Air Force is monitoring and enforcing the institutional controls will need to be conducted. For each site addressed in the Review, the text will need to state (under the site specific discussions) whether or not institutional controls are identified as a component of the remedy, and, if they are, what the institutional controls involve (e.g., prohibiting unrestricted use through deed restriction, prohibiting groundwater pumping, etc.). Under each discussion of areas of noncompliance, the effectiveness of institutional controls will need to be considered.

Response: A new section (Section 5.4) has been added to the five-year review to address the issue of institutional controls. The new section points out that there are no institutional controls currently in place as a part of CERCLA remedial actions at Castle Airport. (The CB-Part 1 ROD does not specify any institutional controls and the SCOU ROD or RODs, which may specify institutional controls, are not final.) The text indicates that subsequent five-year reviews will provide an assessment of institutional controls that may be in place at that time. Individual site discussions will state whether institutional controls are identified as a component of the remedy. The nature and effectiveness of any institutional controls will be discussed and evaluated. Corrective actions (modifications to institutional controls) necessary to eliminate unreasonable risk to human health and the environment will be identified.

Comments

8. [Section 1.2, Conduct of Five-Year Reviews (pp. 1-2 and 1-3)] EPA's concurs with the conclusion in Section 1.2 that a Type Ia review is appropriate since response actions at Castle Airport are ongoing. However, EPA recommends that additional text be included in Section 1.2 to justify why a higher level of review is unwarranted. EPA guidance states that, in certain circumstances, a higher level of review is appropriate even in instances when construction is not complete. Examples cited are:

   - The work on an OU has long been completed and work on the final OU may not be finished for a long time;
   - The Region or the lead agency knows that an Applicable or Relevant and Appropriate Requirement (ARAR) for a specific chemical fails to meet new health standards;
   - The planned response costs or operation and maintenance (O&M) costs may have dramatically increased, indicating potential failure of one or more components of the remedy; and
   - Any other circumstances that indicate the remedy may no longer be protective of human health and the environment.

   The text in Section 1.2 should be expanded to state that none of these examples apply to the site.

   Response: The list of possible justifications for a higher level of review have been added to Section 2.1. The subsequent text states that none of these examples is applicable to Castle Airport and therefore, a Type Ia review is appropriate.

9. [Section 2.3, Groundwater Remediation; Section 2.3.1, Removal Actions (pp. 2-3 and 2-4)] The number of removal actions conducted to address groundwater contamination needs to be clarified. Section 2.3 states there were two removal actions and 2.3.1 states there were three.

Response: Section 2.3 has been corrected and now indicates that there were three groundwater removal actions.

10. [Section 2.3.1, Groundwater Remediation, Removal Actions (p. 2-4)] In Section 2.3.1, the last sentence of the first paragraph states, with respect to the Wallace Road removal action, "Because the majority of the extraction wells were screened across multiple HSZs, the system was decommissioned..." The text should clarify why it was considered undesirable or not useful (e.g., due to cross-contamination) to have extraction wells screened across multiple HSZs.

Response: The text has been modified to indicate that extraction wells screened across multiple HSZs were (and are) not desirable because of the increased potential for cross-contamination.

11. [Section 2.3.2, Groundwater Remediation, Remedial Actions (p. 2-4)] In Section 2.3.2, first paragraph, first sentence, the text should clarify that all parties to the Federal Facility Agreement (FFA), including the regulatory agencies, signed the CB Part 1 ROD. The text implies that AFBCA was the only signatory.

Response: The text has been modified to indicate that all parties to the FFA signed the final CB-Part 1 ROD. The only significance of 5 June 1997 is that this is the date of the final signature.

12. [Section 2.4, Vadose Zone Remediation (pp. 2-7 to 2-8)] The statement in the last paragraph on page 2-7 indicating that removal actions at SCOU sites are "independent of the SCOU ROD" should be clarified. Although removal actions were initiated in advance of remedial decisions for several sites, they are not independent of the SCOU ROD. The SCOU ROD or CB Part 2 ROD will document the final remedial decisions for these sites.

Response: The statement that removal actions at SCOU sites are "independent of the SCOU ROD" has been eliminated. Emphasis of the

revised discussion is that final remedial decisions will not be in place until the final SCOU ROD, and possibly the final CB-Part 2 ROD, is issued.

13. [Section 4.1.1.1, OU-1 Interim ROD/CB Part 1 ROD (pp. 4-3 and 4-4); Section 4.1.2.1, OU-2 Final ROD/CB Part 1 ROD (p. 4-7)] The text in Section 4.1.1.1 references Explanation of Significant Differences (ESD) documentation for the OU-1 system submitted on 28 August 1996 regarding the non-implementation of biological enhancement and the discontinuation of vapor phase treatment of air stripper emissions. The text should clarify the regulatory approval dates of the ESDs. Similarly, the approval date for the OU-2 system ESD, which specified a change from air stripping to GAC for groundwater treatment, should be clarified in Section 4.1.2.1.

Response: The regulatory approval dates for the referenced ESDs for the OU-1 and OU-2 systems have been added to the text in Sections 4.1.1.1 (September 1996 [exact date unknown]; OU-1) and 4.1.2.1 (13 December 1994; OU-2).

14. [Section 4.1.1.2, OU-1 Operational History and Performance Assessment (p.4-4)] In the list of significant milestones in Section 4.1.1.2, the date specified for OU-1 "system shutdown due to TCE concentration in effluent" appears to be incorrect. The date should probably be 12 December 1995, rather than 12 December 1996.

Response: The date should be 12 December 1995 and has been corrected.

15A. [Section 4.1.3.2, Phase 2 Operational History and Performance (p. 4-10)] In the second paragraph, last sentence of Section 4.1.3.2, text should be added at the end of the sentence to state "...because injection well capacity will be improved, thus permitting higher treatment rates." Also, the first part of the sentence, "A well redevelopment of the program...," appears to include a typographical error.

Response: Because the paragraph in question has been completely revised and expanded, the suggested text correction is no longer possible. The discussion now focuses on the ongoing injection well redevelopment program and surface water discharge (intertie to OU-2 and the Casad Lateral) as maintaining treatment plant capacity. The remaining typographical error has been corrected.

15B. In the third paragraph, first sentence of Section 4.1.3.2, "...a realistic assessment" should be replaced with "...an adequate assessment." A similar modification should be made to Section 4.1.4.2 (p. 4-12) with respect to the Castle Vista groundwater treatment system.

Response: The noted terminology has been eliminated. Both sections have been extensively revised and now summarize effectiveness evaluation results for the Phase 2 and Castle Vista systems as presented in the draft TEER.

16. [Section 4.1.4.5, Castle Vista Areas of Noncompliance (p. 4-13)] In the second sentence of Section 4.1.4.5, which states "The groundwater cleanup level for the Castle Vista system, currently MCLs, by default, ...," the text "by default" should be deleted.

Response: The terminology "by default" has been deleted. Reference to the focused feasibility study in the *Castle Vista Landfill B Groundwater Remedial Action Work Plan Addendum–Final* has been added in Section 4.1.4.1. This focused feasibility study verified that MCLs are the appropriate groundwater cleanup criteria for the Castle Vista Plume.

17. [Section 4.1.5, CB Part 1 ROD, Phase 3 (p. 4-15)] The discussion of the Phase 3 groundwater cleanup in Section 4.1.5 should explain that the scope of any necessary future remedial actions for groundwater will be addressed in the Phase 2 TEER, which is scheduled for submittal in September 1995. Additionally, the description of potential Phase 3 remedial actions throughout the Review should consistently

indicate that expansion of existing treatment systems is possible. The text in Section 2.3.2 (Groundwater Remediation, Remedial Actions) and Section 4.1 (CB Part 1 ROD) imply that Phase 3 will potentially involve construction of an additional treatment system, but the text is vague regarding possible expansion of existing treatment systems.

Response: The description of the Phase 3 groundwater remedial action has been updated and expanded throughout the document. The draft TEER was completed and submitted for regulatory agency review on 9 October 1998. A description and discussion of the recommended Phase 3 remedial action presented in the TEER has been added (expansion of Phase 2 treatment plant, eight extraction wells, 12 injection wells, two monitoring wells).

18. [Section 5, Technology Review and Recommendations] Section 5 discusses continuing future adjustment of the "pumping and injection rates at individual extraction and injection wells to improve hydraulic capture and/or maximize mass removal" for all four groundwater treatment systems. Section 5 also states that no corrective actions are identified for the four treatment systems. The Review should explain how "adjustments" are distinguished from "corrective actions."

Response: The definition assumed for a "corrective action" is now established in the introduction to Section 5. Corrective actions are defined as necessary modifications to existing systems or system operation to maintain efficiency of remediation and/or so that the systems remain protective of human health and the environment (e.g., the corrective action being evaluated to reduce carbon use or that implemented to prevent reoccurrence of the surface spill at the Phase 2 treatment plant). Discussion of past and possible future corrective actions at the existing groundwater remedial systems have been added to Sections 4, 5, and 6.

19A. [General] In each of the site-specific sections that address vadose zone sites (Section 2.4), the abbreviated site names (i.e., DBF, DA-4, FS-1, etc.) need to be spelled out and cited parenthetically.

Response: The vadose zone site names are all spelled out and the abbreviated site names are cited parenthetically in the general introduction to Section 2.4. There is no need to reestablish the abbreviated site names in each individual site section.

19B. Threshold background values (TBV^{95}) for Castle Airport need to be explained. Section 2.4.6 (Earth Technology Site 10) references them, but an explanation is not provided.

Response: The discussion in Section 2.4.6 has been revised to refer to "background levels". These are then defined as 95 percent confidence threshold background values (TBV^{95}).

19C. With respect to landfill caps, the term "Class III cover (or cap)" needs to be explained and the ARAR (as specified in the Final Landfill Action Memorandum, 9 September 1997) needs to be cited.

Response: The term "Class III cap" has been replaced with the term "engineered cover". The regulations that the engineered cover will be compliant with are now listed.

Response to RWQCB Comments on the Initial Five-Year Review

This response will, for convenience, repeat RWQCB's comments in standard type followed by the Jacobs Engineering response in bold type.

We have reviewed the *Draft Five-Year Review of Remedial Actions*, (Review) dated April 1998. This document was prepared by Jacobs Engineering on behalf of the Air Force. It is the first five-year review conducted at the former Castle Air Force Base and was initiated by the five-year anniversary of the construction of the Operable Unit One groundwater extraction and treatment system. In general, we found the Review to be complete and well written. We have the following concerns, which mainly address clarification of parts of the text, which should be addressed in the next version of the Review.

General Concerns

1. The status and nature of the Phase 3 groundwater remedial action should be more clearly and consistently explained throughout the text. In the text the Phase 3 remedial action is alternately referred to as "planned" or as tentatively planned (Section 2.3.2: "A Phase 3 system will be designed and implemented, if necessary, to fully meet the objectives of the CB-Part 1 ROD".) Also, it is not clear what the Phase 3 remedial action will possibly entail: an expansion of the existing systems, or an entirely new groundwater extraction and treatment system. In addition, the schedule for the Phase 3 system (including the evaluations of the effectiveness of the other systems) should be more thoroughly discussed in the text.

   Response: The descriptions of the Phase 3 remedial action have been updated and significantly expanded, specifically, the descriptions in Sections 2.3.2.5, 4.1.5, and 5.1.5. Reference is provided to the effectiveness evaluations for OU-1, OU-2, Phase 2, and Castle Vista conducted to support preparation of the draft TEER. The initial recommendations for Phase 3, as stated in the draft TEER, are outlined. Finally, the tentative schedule for design and construction of Phase 3 is presented (Section 7).

2. The specific objectives of the CB Part 1 ROD should be more adequately discussed in the text. (i.e. Section 2.3.2.5 and Section 4.1). In several areas of the text the objectives for the previous interim RODs are specifically listed in a bulletized manner, while the objectives of the current CB Part 1 ROD, which supersedes all the previous groundwater RODs, are only listed in general terms. Since one of the primary functions of the 5 year review is to determine compliance with the controlling ROD or RODs, specifically listing these objectives in the text would help the reader to evaluate whether or not the information in the review is sufficient to determine compliance with the ROD objectives.

Response: The descriptions in Sections 2.3.2 and 4.1 have been modified to more clearly identify the specific CB-Part 1 ROD remedial objectives. It is noted, however, that the CB-Part 1 ROD remedial objectives are brief and very general ("to capture the contaminated groundwater plume(s) within the MCL boundary of the most restrictive contaminant present, and clean up the contaminated groundwater to MCL levels") and do not lend themselves to a bullet list presentation format.

Specific Comments

1. Section 2.3 and 2.3.1, page 2-3. Section 2.3 refers to "two removal actions" while section 2.3.1 refers to "three removal actions" for groundwater remediation. This discrepancy should be reconciled, and the section in error should be revised as appropriate.

Response: The text in Section 2.3 has been modified to refer to three removal actions (Discharge Area 4, Wallace Road, and Building 84).

2. Section 2.3.2, and subsequent subsections, pages 2-4 to 2-7. Where appropriate, the section for each remedial action that has the option of discharge of the treated water to surface water (Casad Lateral or OU-2 and Phase 2) in the CB-Part I ROD should note this in the general description of the remedial action. Also, the schematic

figures for each of these remedial actions with the surface water discharge option should be revised to show the discharge pipeline in addition to the injection wells.

Response: The text for OU-2 and Phase 2 has been modified to note the potential for discharge of limited amounts (ROD restrictions; NPDES permit limits) of treated water to surface water. Specifically, the potential for OU-2 to discharge to the Casad Lateral and for Phase 2 to discharge to the Castle stormwater canal system or the Casad Lateral are mentioned. Figures 2-5 and 2-7 have been modified to show the surface water discharge options.

3. Section 2.3.2.5, page 2-7. The section for the Phase 3 should be revised to indicate when the "effectiveness studies of OU-1, OU-2, and OU-3" will be conducted to determine "if additional or modified remedial action is necessary in the Main Base Plume region to meet the remedial objectives defined in the CB-Part 1 ROD". Also, this section may need to be revised to address our General Comment No. 1 above.

   Response: The descriptions of the Phase 3 remedial action have been updated and significantly expanded specifically, the descriptions in Sections 2.3.2.5, 4.1.5, and 5.1.5. Reference is provided to the effectiveness evaluations for OU-1, OU-2, Phase 2, and Castle Vista that were conducted to support preparation of the draft TEER. The initial recommendations for Phase 3 as stated in the draft TEER are outlined. The tentative schedule for design and construction of Phase 3 is also presented (Section 7).

4. Section 2.4, page 2-7. This section states that: "SCOU sites where a removal action has been completed, is ongoing, or is in the planning stages, are identified since these actions are independent of the SCOU ROD. Removal actions have been completed and regulatory agencies have concurred with no further action (NFA) at two SCOU sites, B871 and the Detonation and Burn Facility (DBF)...Each of the other SCOU sites [non-removal action sites] will ultimately be identified as requiring remedial action or as requiring no further action based on multiple evaluative criteria, including risk."

This statement is not entirely true and should be revised for accuracy. For clarification, actions at removal sites are not independent of the SCOU ROD. Removal actions are simply pre-ROD, interim actions that may or may not constitute the final remedy for the site. The final remedy (either remedial action or NFA status) is determined in the ROD. In these two instances (B871 and DBF), the regulatory agencies and the Air Force have determined that the removal actions were sufficient in scope to address the environmental concerns at the site, and that no further action is required at the site. This NFA status as the final remedy for the site, however, will not be final until the ROD is signed. Even more tentative are the SCOU sites where a removal action is currently ongoing or only in the planning stages. At these sites, the removal actions may not constitute the final remedy for the site and additional remedial action at the site may be specified in the ROD (although in most cases the base closure team has selected a removal action that should be sufficient to constitute a final remedy). Furthermore, all SCOU sites, including those sites where a removal action has been conducted, will have final remedies selected in the SCOU ROD or the subsequent CB Part II ROD based on multiple evaluative criteria.

Response: The text in section 2.4 has been revised. The statement that removal actions are independent of the SCOU ROD has been removed. Added text notes that final remedies for SCOU sites, even those undergoing removal actions, will be determined in the SCOU ROD (possibly two SCOU RODs) or the subsequent CB-Part 2 ROD.

5. Section 2.4.5, page 2-11. This section incorrectly states that "A draft closure report was issued in December 1997 (Jacobs, 1997b) and is currently awaiting agency concurrence." In actuality, the agencies commented on this report in February 1998, prior to the issuance of the Review, and we are awaiting an Air Force response to our comments. However, since the status of the FS-2 comment and response activities will likely change again during the time period in which the Review is being commented on and finalized, we suggest that a more generic statement on the status of the FS-2 site be included in the text instead of the current sentence. A statement

such as: "A draft closure report has been issued and closure is pending resolution of several remaining issues" should be sufficient.

Response: The text in Section 2.4.5 has been revised as suggested. The discussion of the status of all SCOU removal actions has been updated to reflect changes during the six months since the draft five-year review was issued (April 1998).

6. Section 2.4.8, page 2-13. This section states that the Air Force is awaiting agency concurrence on the focused feasibility study that was issued for FTA-1 in February 1998. The agencies have commented on this report, and there are several remaining issues to be addressed. Here again, a more generic statement should be placed in the text to indicate that the status of the report is pending resolution of several remaining concerns.

Response: The existing text has been replaced by a more-generic statement regarding status. As noted in the response to Comment 5, all discussions of SCOU removal action status have been updated.

Also, the last paragraph should be revised to indicate that the second SVE removal action is currently ongoing at the site.

Response: The text has been revised to note that the second SVE removal action is still operating at the FTA-1 site.

7. Section 4.1, page 4-2. The discussion of the Phase 2 remedial action (fourth paragraph of this section) should be revised to indicate that Phase 2 also involved constructing and operating a new extraction system and treatment plant for the deeper hydrostratigraphic zones.

Response: The discussion of the Phase 2 remedial action in Section 4.1 has been revised to indicate that the action involved construction of a new

treatment plant and that the Phase 2 system focus was hydraulic control and remediation of the Main Base Plume in the deeper HSZs (the USS, LSS, and Confined HSZs).

8. Section 4.1.1.2, page 4-4. The third bullet of this section on the operational history of the OU-1 system states: "September-November 1995—TCE concentration in final effluent unknowingly exceeds treatment standard (0.5 μg/l)". This bullet should either be revised to specify exactly how and why the treatment standard was "unknowingly" exceeded (i.e. operator error, inadequate data analysis, laboratory error, etc.) or should be revised to simply state that the treatment standard was exceeded.

Response: The word "unknowingly" has been removed from the bullet item.

9. Section 4.1.1.5, page 4-6. This section indicates that "no areas or aspects of the OU-1 groundwater treatment system operation have been identified as noncompliant with the CB-Part 1 ROD." This is inaccurate, in that discharge standards were temporarily exceeded (and a notice of violation of the CB-Part I requirements was actually issued by the USEPA). This section should be revised to indicate that the discharge standards were temporarily exceeded and what corrective actions were initiated to help prevent this in the future.

Response: The text in Section 4.1.1.5 has been expanded and describes the noncompliance event that occurred from September through December of 1995. The issuance of a Notice of Violation is documented and the corrective actions taken to prevent future occurrences of a similar event are listed.

10. Section 4.1.3.2, page 4-10. This section should be revised to discuss the discharge of treated groundwater to surface water (the Casad Lateral) in compliance with the current NPDES permit and the provisions of the CB-Part 1 ROD.

Response: A discussion of the discharge of treated groundwater from the Phase 2 system to the Casad Lateral has been added to Section 4.1.3.2. The text notes that provision for this discharge is included in the CB-Part 1 ROD and that the discharge is covered by a current NPDES permit.

11. Section 4.1.3.5, page 4-11. This section should be revised to discuss the discharge of untreated groundwater from the treatment plant that occurred in December 1997, and the corrective actions implemented to help prevent similar spills from occurring in the future.

Response: Discussion of the small surface spill of untreated groundwater that occurred from the Phase 2 plant on 27 December 1997 has been added to Section 4.1.3.5. Corrective actions taken to prevent reoccurrence of such a spill are now listed in the text.

12. Section 4.1.4.5, page 4-13. The statement that "the groundwater cleanup level for the Castle Vista system, currently MCLs, by default, may be changed in the future" is unclear and should be revised for clarity. Is the Air Force expecting that less stringent cleanup levels will be acceptable in the future? The text should be revised to indicate how and why the cleanup levels would be expected to be changed.

Response: The statement that "the groundwater cleanup level for the Castle Vista system...may be changed in the future" has been deleted. Reference is now included in Section 4.1.4.1 to the final (pending) *Castle Vista Landfill B Groundwater Remedial Action Work Plan Addendum Report* and the included focused feasibility study. This study documented the appropriateness of using MCLs as the groundwater cleanup levels for the Castle Vista plume.

13. Section 5.1.2, page 5-2. This section should be revised to discuss the mechanical failure of one of the GAC vessels, the repercussions of this failure in terms of how it

affects the treatment capacity or quality of the OU-2 system, and any corrective actions that will be undertaken as a result of the failure.

Response: Discussion of the mechanical failure of one of the carbon vessels at the OU-2 plant has been added to Section 5.1.2. It is further noted that the vessel represented excess treatment system capacity and that the failure did not affect treatment capacity and did not result in any increased risk to human health or the environment. The text further indicates that no corrective actions have been identified or undertaken as a result of this failure and that the failure does not represent a noncompliance event.

14. Section 5.1.3, page 5-2. This section should be revised to discuss the diminished capacity of the Phase 2 injection wells, and the subsequent discharge of treated water to the Casad Lateral. Any corrective actions identified for the injection wells should also be discussed. Also, the spill of untreated groundwater from the treatment plant in December of 1997, and corrective actions to help prevent similar spills in the future should be added.

Response: Discussion of the diminished capacity of Phase 2 injection wells and discharge of treated water from the Phase 2 plant to the Casad Lateral (intertie to the OU-2 discharge line) has been added to Section 5.1.3. The revised text mentions that the cause of the diminished capacity is still under evaluation, and that a program of intermittent redevelopment of selected injection wells will be the likely corrective action. Discussion of the small surface spill of untreated groundwater that occurred from the Phase 2 plant on 27 December 1997 has also been added to Section 5.1.3. Corrective actions implemented to prevent reoccurrence of such a spill are not listed in Section 5.1.3; reference is made to the list of corrective actions provided in Section 4.1.3.5.

15. Section 5.1.4, page 5-3. This section should be revised to state that the Air Force has agreed to install a wellhead treatment unit on municipal well AM-6 since this well is

part of the plume extraction system. The agencies believe that the Air Force's commitment is well beyond the "tentative" stage.

Response: The word "tentative" has been removed. The text in Section 5.1.4 now states that Air Force plans to install wellhead treatment on AM6 are presently under discussion. AM6 can only be designated as an extraction well after a wellhead treatment system has been installed; only after wellhead treatment has been installed will discharge from AM6 meet the treated water discharge standards established in the CB-Part 1 ROD.

16. Section 6, page 6-1. The portion of this section that deals with the CB-Part 1 ROD seems to be at odds with the body of the text that precedes it, and should be revised and expanded to address both the following comments, and our comments elaborated on in our General Concerns above. Also, additional text in preceding sections (especially Sections 4 and 5) will need to be revised to adequately support this section. The portion of this section that deals with the CB-Part 1 ROD states, in it's entirety:

"The groundwater remedial actions selected and implemented at Castle Airport remain protective of public health and the environment but do not fully meet the objectives of the CB-Part 1 ROD. By continuing the phased approach to groundwater remediation, the Air Force is taking those steps necessary to fully meet the objectives of the CB-Part 1 ROD. The steps were outlined in Section 5, Technology Review and Recommendations."

This section would provide for a good summary section for the preceding text if additional information is provided. The following should be added to this section: A specific and explicit listing of which objectives of the CB-Part I ROD are not being met, how and why they are not being met (i.e. insufficient plume capture, insufficient data to characterize plume capture, etc.), and the steps that are planned to insure full compliance with all the objectives of the CB-Part 1 ROD. This information could probably most efficiently be provided in a table format, since it will already have been discussed earlier in the report in a narrative form.

The statement that "the groundwater remedial actions selected and implemented ...do not fully meet the objectives of the CB-Part 1 ROD" is not fully supported by the information in Section 4 of the Review. For OU-1 and OU-2, Section 4 of the Review indicates that both systems are effectively providing hydraulic control of the plumes and capturing contaminated groundwater within the 5 μg/l contour as required by the CB-Part 1 ROD. For the Phase 2 system and the Castle Vista system, Section 4 of the report indicates that the treatment systems have not been in operation long enough for a realistic assessment of performance. For all four systems, however, Section 4 states that no areas or aspects of the groundwater treatment systems operation have been identified as noncompliant with the CB-Part 1 ROD. The reader is left with the overall impression after reading Section 4 that the objectives of the CB-Part 1 ROD have either been fully met (for OU-1 and OU-2), or are currently under evaluation, and that no additional changes to the systems are required. This may or may not be accurate with regard to plume containment, as for at least the Phase 2 and the Castle Vista systems there is insufficient data to date to indicate whether or not the systems are containing the plumes as required in the CB-Part 1 ROD. For all systems, the CB-Part 1 ROD objective that stipulates cleanup of the groundwater to MCL levels has certainly not yet been met (and we don't expect that it will be met until sometime in the future).

Similarly, Section 5 does not adequately document the information required to support the statement that "the Air Force is taking those steps necessary to fully meet the objectives of the CB-Part 1 ROD. The steps were outlined in Section 5, Technology Review and Recommendations." For all four systems, Section 5 simply states that adjustments to the pumping and injection rates at individual extraction and injection wells to improve hydraulic capture and/or maximize mass removal will continue to be made in the future. For the Phase 2 and Castle Vista systems the Air Force will also evaluate adjustments to the treatment train to compensate for a greater than assumed carbon usage rate. Also, for all four systems Section 5 states that no corrective actions are identified. Section 5 also states, that "the Phase 3 groundwater treatment system will be constructed , if necessary, for overall groundwater remediation at Castle Airport to fully meet the objectives of the CB-Part 1 ROD. Again, the reader is left with the overall impression after reading Section 5 that the objectives of the CB-Part 1 ROD have either been fully met and that only minor optimization of the existing systems are required in the future. The discussion of Phase 3 being implemented is a catch-all to generically deal with any areas of non-compliance. Additional details and commentary on the specific steps the Air Force intends to implement to fully comply with the CB-Part 1 ROD should be added to Section 5.

Also, for each of the treatment systems, the Review indicates that "no corrective actions are identified" to be implemented. The Review should be revised to indicate exactly what this statement means, since it seems to be counter to the argument that this section identifies the steps the Air Force will undertake to fully comply with the CB-Part 1 ROD.

Response: The text in Sections 4 and 5 has been extensively revised, based on results of effectiveness evaluations presented in the draft TEER. The text now lists specific areas of noncompliance (with the CB-Part 1 ROD) for the Main Base Plume and the Castle Vista Plume remedial systems. The major area of noncompliance identified for the Main Base Plume remedial system is the potential lack of complete hydraulic control of the plume in the USS, LSS, and Confined HSZs. The major area of noncompliance identified for the Castle Vista Plume remedial system is the lack of complete hydraulic control of the plume in the USS HSZ. Neither remedial system has, to date, achieved the ultimate objective of the CB-Part 1 ROD: cleanup of the groundwater to MCLs. The latter is known to be a long-term objective of remediation and it is not expected that this objective would have been achieved this early in the remedial process. A Phase 3 remedial action has been proposed in the draft TEER to address the potential lack of hydraulic control of the Main Base Plume. Specifics of the proposed Phase 3 remedial action are now outlined in

Sections 5 and 6. The installation of wellhead treatment at AM6 addresses the potential lack of hydraulic control in the Castle Vista Plume (USS HSZ). This proposed plan is described in Section 4 and outlined in Sections 5 and 6. Section 6 has been extensively revised to provide a concise summary of the preceding discussions in Sections 4 and 5. Corrective actions previously implemented (discharge standard exceedance at OU-1 and surface spill at Phase 2) and under development (redevelopment of injection wells and carbon usage) are now discussed in Sections 4 and 5 and included in the summary discussions in Section 6.

17. Sections 4 and 5 should be revised to specifically and explicitly list areas of non-compliance, and the steps that will be implemented to bring the systems into compliance with the CB-Part 1 ROD, and support the overall conclusions contained in Section 6.

Response: The text in Sections 4, 5, and 6 has been extensively revised. See response to Comment 16.